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ABSTRACT

In this working paper and executive summary, focus is on procedures to be used in cost-effectiveness studies of the University of Mid-America/State University of Nebraska (UMA/SUN) delivery system of open learning. Two major questions are addressed: Should cost-effectiveness studies be undertaken, and if so, what kind of studies? The planning process and literature review was undertaken to identify cost-effectiveness analysis issues pertinent to UMA/SUN and open learning, and four major papers were generated. They are included in this report: (1) "Thoughts on Learning Effectiveness Comparison Studies," by Dennis D. Gooler; (2) "Economic Analysis of the UMA/SUN Open Learning System," by Philip and Keith Lumsden; (3) "A Review of the Context of Cost Analysis," by Philip Doughty and Albert Beilby; and (4) "Cost-Effectiveness Analysis Alternatives for Open Learning Programs," by Philip Doughty. A proposed schedule for cost-effectiveness studies over a five-year developmental period follows a description of planned data collection activities for the program evaluation. (LBH)

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PRELIMINARY COST-EFFECTIVENESS CONSIDERATIONS FOR UMA/SUN

Executive Summary No. 4

Office of
Research and Evaluation

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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Executive Summary

PRELIMINARY
COST-EFFECTIVENESS CONSIDERATIONS
FOR UMA/SUN

A Summary of Work
Completed Pursuant to
NIE Assignment No. 2B, 1974

Office of Research and Evaluation
State University of Nebraska
University of Mid-America
February 1, 1975

This paper has been prepared as a Summary of work on this topic, for inclusion in the 1974 Final Report to NIE. For elaboration of the work summarized herein, the reader is urged to consult the Working Papers cited in this document. Working papers may be obtained by writing the Office of Public Affairs and Information Services, P. O. Box 82006, Lincoln, Nebraska, 68501.

The coordinator and primary author of the effort is G. Roger Sell. Contributions have also been made by Dennis Gooler and Philip Doughty.

PRELIMINARY
COST-EFFECTIVENESS CONSIDERATIONS
FOR UMA/SUN

Introduction

In a time of declining enrollments, increased costs, faculty terminations, and a general lack of growth, any program which emerges as a new effort in postsecondary education will surely undergo more than the usual critical scrutiny from a range of interested publics. In previous decades, innovations were welcomed, largely because there was sufficient resources for anyone in higher education. An "add-on" view of economics prevailed: if we have need for new resources to do something, let's create new resources.

The times are different now. If new programs are to begin, or, indeed, if old programs are to continue, we must proceed under a policy of resource reallocation, not add-on. Consequently, there is renewed interest in notions of the relationship of cost to effectiveness. And many in higher education are unfamiliar with such thinking.

SUN is rightfully regarded as a major new effort in postsecondary education. Because the program was born in an era of economic difficulties in higher education in general, there was good reason to raise questions about the role of this new program in the overall educational picture in Nebraska (and the UMA region), about the economic impact of SUN on other institutions, and of the cost-effectiveness of SUN itself.

There were and are many important political questions about the existence of SUN. These questions must eventually be carefully and thoughtfully addressed. But so too must some very basic economic questions be addressed: What does it cost to provide educational services to adults through SUN? How do those costs compare to costs of other educational institutions?

Hopfully, decisions about the worth of an educational enterprise should not be made solely on the basis of cost, but will equally consider questions of effectiveness. Whether something is worth the cost depends on what you get for that cost. Too often, the effectiveness part of cost-effectiveness is ignored. Effectiveness data seem more elusive, less amenable to rigorous collection or interpretation. In the case of SUN, however, effectiveness determination is extremely important. Cost factors alone, while necessary in deliberating the future of the program, are not sufficient.

It may be helpful to think about cost-effectiveness in SUN in two ways: internal cost effectiveness (what is the relative cost and effectiveness of alternative kinds of courses or course development procedures?); and external cost-effectiveness (how cost effective is SUN compared to the University of Nebraska-Lincoln, or compared to the British Open University?). Both kinds of questions are relevant.

One of the 1974 NIE work assignments appears to address questions of internal cost-effectiveness. The work assignment reads:

> Develop a plan for the use and evaluation (including cost and learning effectiveness comparison studies) of at least four different approaches to courseware development. These are to include (a) (12 month) high-production-quality, high-cost TV programming; (b) (9-month) low-cost TV programming; (c) (6 month) adaptations of existing television programming; (d) (9 month) non-television, other media programming.

The work assignment was correct in recognizing that courses in SUN might be developed in a variety of ways. Two things were important in that recognition: some ways of developing courses will inevitably be more expensive than others; and, no one really knows what approaches to courseware development and, more importantly, what kinds of courses, will result in more or better learning on the part of enrolled adults.

While the work assignment thus correctly pointed to a number of extremely important questions, the assignment was also clearly inadequate in its assumptions about the way in which the questions ought to be thought about. Therefore, the work undertaken during 1974 on this assignment focused largely on clarification of what the issues really are in this area of cost-effectiveness.

This chapter describes SUN efforts to address the NIE work assignment, with particular emphasis on how to think about effectiveness, and how to subsequently relate effectiveness to cost. It should be pointed out that the work assignment called for developing a plan for conducting cost and learning effectiveness comparison studies, not for actually conducting those studies.

This paper contains three sections. Following this introduction, the procedures used to conduct the planning suggested by the work assignment are outlined. Next, the papers developed in the planning process are identified. Finally, a plan for future cost-effectiveness work by UMA/SUN is set forth.

We recognize that only a beginning has been made in this area. Hopefully, this is an appropriate beginning to an intelligent and thoughtful analysis of the cost-effectiveness of UMA/SUN.

Procedures Used in the Planning of Cost-Effectiveness Studies

The first attempts to plan for the kind of comparison studies of courseware development suggested by the work assignment were aimed at questioning the intent and viability of such studies. The Office of Research and Evaluation drafted an initial statement on learning effectiveness comparison studies, and the Office of Business and Finance contracted with The Esmee Fairbairn Economic Research Center (TEFERC) for a paper on the economics of the open learning program. It was the intent, at that point, to approach comparison studies from both the cost perspective and the effectiveness perspective.

The statements resulting from this work were reviewed by SUN staff to assess the kinds and quantities of comparison studies which would be both desirable and feasible starting in 1975. The staff found that these initial statements on learning effectiveness and cost comparison studies were suggestive rather than conclusive in specific recommendations for 1975 and beyond, and thus required additional work.

First, a review of the literature was initiated to identify pertinent issues and studies of cost-effectiveness in postsecondary education. Staff in the Office of Research and Evaluation discovered that a similar review had already been accomplished by Dr. Philip Doughty of Syracuse University. The major objectives of the Doughty review were: (a) to identify and examine assumptions which underlie systems analysis as an aid to decision makers; (b) to view assumptions within a given educational setting; (c) to review existing applications of cost analysis in various educational contexts; and (d) to consider the design of a generic cost analysis process model for use by inservice and preservice teacher educators. Although the Doughty report focused on cost analysis and teacher education, it served as a reference for representative models and issues in cost-effectiveness analysis in higher education in general. It was the judgment of the staff that the Doughty review of the issues and literature was comprehensive and well organized. Therefore, rather than invest additional resources to produce a similar statement, the Office of Research and Evaluation made arrangements to reprint the Doughty review as a "state of the art" paper in cost-effectiveness analysis.

The next step taken was to identify issues of cost-effectiveness analysis particularly relevant to open learning and UMA/SUN. Of the large range of issues in cost-effectiveness analysis which UMA/SUN could address, some judgment had to be made about what issues would be most profitable to invest in. To help in this

judgment, and with a background in both the theory and the practice of cost-effectiveness analysis, Philip Doughty was asked to prepare a brief paper which would identify cost-effectiveness analysis issues pertinent to UMA/SUN and open learning. That paper was prepared and reviewed by SUN staff.

The paper itself was seen as one vehicle to inform SUN staff of the issues and options for cost-effectiveness analysis. A second part of the strategy was to meet with Dr. Doughty in a seminar arrangement, whereby SUN staff could raise questions and probe into the application of cost-effectiveness analysis. This meeting was seen as important, in that staff outside the Office of Research and Evaluation are the primary internal users of cost-effectiveness studies and might profit from an examination of the issues therein. The seminar with Dr. Doughty was well attended, having representatives from all office areas in SUN. Although the specific issues discussed at that seminar are not reported here, it was felt by SUN staff that Dr. Doughty had identified some of the important implications in cost-effectiveness analysis for UMA/SUN, and that a specific plan should be drafted to address these concerns. The plan for cost-effectiveness studies reported in the final section of this paper draws heavily on the results of the seminar with Dr. Doughty.

The Office of Research and Evaluation has also made a start into the analysis of course costs. In that cost-effectiveness studies require the proper analysis of development and delivery costs, staff from both the Office of Business and Finance and the Office of Research and Evaluation have worked cooperatively (a) to begin to identify the student and course costs for the first two courses developed and delivered by SUN, and (b) to locate areas where cost data are not available in sufficient detail to make certain descriptions and comparisons. It is anticipated that future work in cost-effectiveness analysis will involve both Offices.

Papers Developed in the Planning Process

During the 1974 calendar year, four main papers were developed in the considerations of cost and learning effectiveness comparison studies. The four papers are:

1. Thoughts on Learning Effectiveness Comparison Studies - Dennis D. Gooler, Director, Office of Research and Evaluation, State University of Nebraska.

2. Economic Analysis of the UMA/SUN Open Learning System - Richard Attiyeh and Keith Lumsden, Associates, The Esmee Fairbairn Economic Research Center.

3. A Review of the Context of Cost Analysis - Philip Doughty, Assistant Professor, Department of Instructional Technology, Graduate School of Education, Syracuse University.

4. Cost-Effectiveness Analysis Alternatives for Open Learning Programs - Philip Doughty, Assistant Professor, Department of Instructional Technology, Graduate School of Education, Syracuse University.

Abstracts of the four papers are attached to this paper. The papers, themselves, can be obtained from the set of working papers developed during 1974 by the Office of Research and Evaluation.

A Plan for UMA/SUN Cost-Effectiveness Studies

The two main questions addressed in this section are: (1) Should UMA/SUN engage in systematic cost-effectiveness studies; and, (2) If so, what kinds of studies should be undertaken?

Should Cost-Effectiveness Studies Be Undertaken?

The rationale for UMA/SUN engaging in cost-effectiveness studies appears to be compelling for at least five reasons. First, the sponsors of UMA--NIE, foundations, and affiliates--must judge the worth of their investment in the enterprise. UMA will probably be judged on the basis of its viability as an organization which is distinct from existing agencies and which contributes to

the educational and general health of the region. UMA will also probably be judged on the efficiency of the products it produces and the services it renders. Also, UMA will probably be judged on the benefits and costs which UMA products and services create for individuals, communities, and institutions. Thus, given that other agencies are competing for funds from the sponsors of UMA, it behooves UMA to be prepared to defend its program in terms of distinction, efficiency, and benefits. Comparisons will be made among competing investments; data and information generated by UMA could be influential in those comparisons.

Second, the SUN (and other affiliates of UMA) will probably be required to seek some level of state support, at least during the next five years. This, in turn, means competition with other state agenices for funding; it also means that for some state agencies SUN will be a threat to their funding base. Furthermore, SUN may be a threat to the "market" which existing institutions serve. It would be to SUN's advantage if it could demonstrate: (a) benefits which accrue to other agencies as a result of SUN's operation; (b) that its clientele are not being served by existing programs; (c) that definite individual and community benefits result from SUN; and, (d) that where credit is offered, the courses are academically sound and produce the intended results. The climate for SUN will be influenced by other institutions in the state, and how the state legislature recieves SUN. Studies which address the concerns of both advocates and opponents of SUN would be beneficial in developing a positive climate for the growth of SUN.

Third, the students of SUN (and other state affiliates of UMA) must make judgments about the worth of obtaining educational experiences and services which are offered. Given competing demands, it must be clear that SUN is an opportunity which addresses the interests of its target population. Information about how SUN, and other state affiliates of UMA, helps students meet their

personal goals would be advantageous. It would also be helpful to document how SUN is responsive to the needs of the population which it serves, and what those needs are. The tuition rates for SUN courses must also be compatible with students willingness or capabilities of paying. One of the premises for the UMA/SUN program is that sufficiently large numbers of student-clients will create economies of scale. Both the number of students and the rate of tuition will impact on the economic viability of SUN.

Fourth, the top level decision makers in UMA/SUN require timely and trustworthy information for internal decisions. For example, decisions must be made about the acquisition of courseware, either to be modified or accepted without change. Cost-effectiveness studies could help to identify results obtained in previous use of a course, as well as initial and long-range cost implications of courses acquired for use in UMA states. A second kind of internal decision is the recommendation to the Academic Council for a course to be developed or acquired. In this case not only the potential "market" for the course, but also projected course cost and effectiveness data, would be beneficial. Also, given that some flexibility exists in setting tuition rates, cost studies could help to construct demand (enrollment) curves which relate tuition to enrollment patterns under given conditions of course content, quality, and/or services.

Fifth, staff in UMA/SUN (e.g., instructional designers, producers, learning center coordinators) make decisions about specific content, instructional strategies, uses of media, course structure, and student services. If course cost and/or effectiveness data were available at the appropriate time, staff could use such data as a resource in their decisions.

Although these five reasons serve as support for the conduct of cost-effectiveness studies, the undertaking of such studies must also be judged

in relation to competing activities within the organization. Each office within UMA/SUN has ongoing activities slated for next year, to which added cost-effectiveness studies might be a burden. Furthermore, it is not entirely clear what the results of cost-effectiveness studies would be (in terms of specific data), or how that data would be used in the decision making process. In short, there are some unknowns about how costly, effective, and beneficial cost-effectiveness studies might be. However, for the reasons given above, it is recommended that UMA/SUN undertake a few strategic studies which over time could address the issues raised in this report.

What Kinds of Cost-Effectiveness Studies Should be Undertaken?

It is recommended that the criteria for selecting cost-effectiveness studies to be undertaken by UMA/SUN recognize major areas of vulnerability to the organization, and honor a proactive rather than reactive approach to such studies.

One major source of vulnerability for UMA/SUN is its dependence on external funding during the five year development period. Although projections have been made that operational aspects of UMA and affiliates could be self-supporting after the five year development period, there is no guarantee that outside funding will be extended throughout the first five years. To increase the probability that outside funding is obtained over the developmental period, an ongoing dialogue and information flow should continue with present and potential funders, as well as institutional leaders. The recipients of information should include program directors in NIE, other governmental offices, and foundations; state legislatures and their committees; and, heads of existing institutions. The objective of such dialogue and information flow would be threefold. One objective would be to adequately and accurately represent the status of UMA and its affiliates. A second objective would be to address issues of importance

to decision makers in outside agencies, including issues such as who UMA and its affiliates serves and who it does not serve, how UMA and affiliates overlap with and are distinct from existing programs, projected plans over the next five years, the projected impact on existing institutions, and contributions which UMA and affiliates are making to existing institutions, communities, and individuals. A third objective would be to carefully identify the support base which UMA and affiliates require over the next five years, the rationale for it, and the plans for financing UMA and affiliates after the five year developmental period.

Internal to the organization, one major source of vulnerability is the lack of communication and coordination across offices. Quality, or effectiveness, is not a univariate concept; neither is cost. All of the offices and individuals in UMA/SUN contribute to both the quality and cost of the enterprise. To the extent that cost and effectiveness information can be used in decisions to select particular instructional strategies, media, and intended outcomes, the organization should be less vulnerable from within.

To address these concerns, it is recommended that the following cost-effectiveness analysis activities be undertaken by UMA/SUN over the next five years. The activities are ordered with respect to (1) activities which should become a part of routine data collection; (2) activities which should be targeted for 1975 and beyond; and, (3) activities which go beyond strictly cost-effectiveness analysis, but which are important to consider in judging the impact and cost of the enterprise. A proposed schedule for cost-effectiveness studies over the five year developmental period follows the description of planned activities.

1. Activities which should become a part of routine data collection.

   a. Identify the potential (and actual) clientele of the open learning program and differentiate them, as appropriate, from the clientele of conventional programs.

   b. Document referrals to and enrollments in existing programs which result from advisory services and/or course enrollments in SUN and other UMA affiliates.

   c. Provide consulting services to existing programs to help them sharpen their own program's resources and goals, and document the effect of that consultation.

   d. Share and compare information with institutions through WICHE, Empire State, BOU, and other open learning programs.

   e. Assess courses to be acquired in terms of potential effectiveness and long-range cost implications.

2. Target activities for 1975-1979 (detailed).

   a. Develop descriptive models which portray the costs and effectiveness of courses already delivered.

      (1) Identify and describe per course/per student costs for Accounting I and Introductory Psychology in terms of: (a) design, production, research, evaluation, and delivery; and (b) media employed, i.e., television, text, study guide, newspaper, and audio tapes (Accounting I only).

      (2) Identify and describe outcome measures for Accounting I and Introductory Psychology in terms of (a) unit test data; (b) unit evaluation data; (c) end-of-course evaluation data; and, (d) student interview data.

      (3) Portray cost and outcomes data in a format conducive to cost-effectiveness analysis.

      (4) Predict the costs and outcomes for the second offerings of Accounting I and Introductory Psychology.

   b. Engage in an experimental study with the University of Nebraska at Lincoln (UNL) where Accounting I can be compared in cost and effectiveness to a UNL introductory accounting course on campus.

      (1) Design research study so that proper interpretation can be made of differences in Accounting I and UNL conventional course which result in measured outcomes, including achievement, appeal, and application.

(2) Identify and describe costs associated with the experimental (SUN Accounting I) and control (UNL introductory accounting) courses, including all relevant assumptions.

(3) Describe in detail the experimental and control groups, as well as the process ("treatment") administered.

(4) Portray cost and outcomes data and present in a format conducive to cost-effectiveness analysis.

(5) Draw conclusions from the study, including the methodological and practical constraints and the value of the data to decision makers.

(6) Report findings of study to UMA/SUN and UNL parties.

c. Conduct a feasibility study to determine what information needs exist in course development and delivery and how data on either cost or effectiveness would make a difference.

(1) Interview development and delivery staff to identify specific decisions made in selecting (a) course goals; (b) instructional strategies; (c) media; (d) assessment procedures and instruments; and (e) services offered to students.

(2) Describe both actual and potential data used in specific development and delivery decisions.

(3) Identify and describe the constraints and capabilities which exist for development and delivery.

(4) Draw conclusions about the desirability and feasibility of providing cost and/or effectiveness to staff in the development and delivery of courseware and services.

(5) Identify at least one course to experiment with staff on the generation and use of cost-effectiveness data.

d. Document the costs of existing programs and the assumptions to be used in comparing conventional program costs with open learning program costs.

(1) Select at least three UMA/SUN courses (one UMA-developed, one UMA-adapted, one UMA-acquired) for cost comparisons with other institutions.

(2) Identify at least one each of the following institutions for cost comparisons with the above three courses: an open learning program (e.g., Empire State or The BOU); a 2-year community college; a 4-year college; a university.

(3) Describe assumptions for cost comparisons and analyze course costs by institution.

(4) Draw conclusions about the relative cost of UMA/SUN courses when compared with other institutions.

(5) Report findings of the study, as well as implications for the operation of UMA/SUN.

e. Analyze the cost and effectiveness data from approximately ten UMA/SUN courses in terms of goals, media, unintended consequences, and unanticipated results.

(1) Across the ten course contents, identify level of course goals to be realized (objectives) and identify course costs and effectiveness data by level of course objectives.

(2) Construct a typology of media employed across the ten courses and identify course costs and effectiveness data by types of media employed.

(3) For each of the ten courses, describe the unintended costs and/or effects of the course.

(4) For each of the ten courses, describe the unanticipated positive and negative results from the course.

(5) Portray the cost and effectiveness data across the ten courses in terms of goals, media, unintended consequences, and unanticipated results.

(6) Draw conclusions as appropriate from the comparisons.

f. Select at least one course in which to experiment with different media, and seek to determine the impact of those media on course costs and effectiveness.

(1) Develop one body of course content with specified goals, assessment procedures and student services, in at least three media combinations: (a) print only, (b) nonprint only, and (c) print and nonprint.

(2) Following rigorous experimental design procedures, randomly assign subjects (students) to each of the three experimental forms of the course. Also, employ a control group which is not subjected to any of the three treatments.

(3) Document course costs as well as outcomes, using the same assessment procedures.

(4) Portray the costs and outcomes data in a format conducive to cost-effectiveness analysis.

(5) Draw conclusions from the study and identify implications for media selection in the particular content area.

(6) Identify what generalizations, if any, apply to other content areas, course goals, and assessment procedures.

(7) Critique the worthwhileness of the study, including if additional inquiries of this type are productive.

3. Activities which go beyond cost-effectiveness analysis, but which are important to consider.

(a) Begin a baseline study of the impact of UMA-SUN on existing institutions, including impact on (1) student enrollments; (2) faculty; and (3) services and programs.

(b) Begin a baseline study of the impact of UMA-SUN on the communities in states in the region.

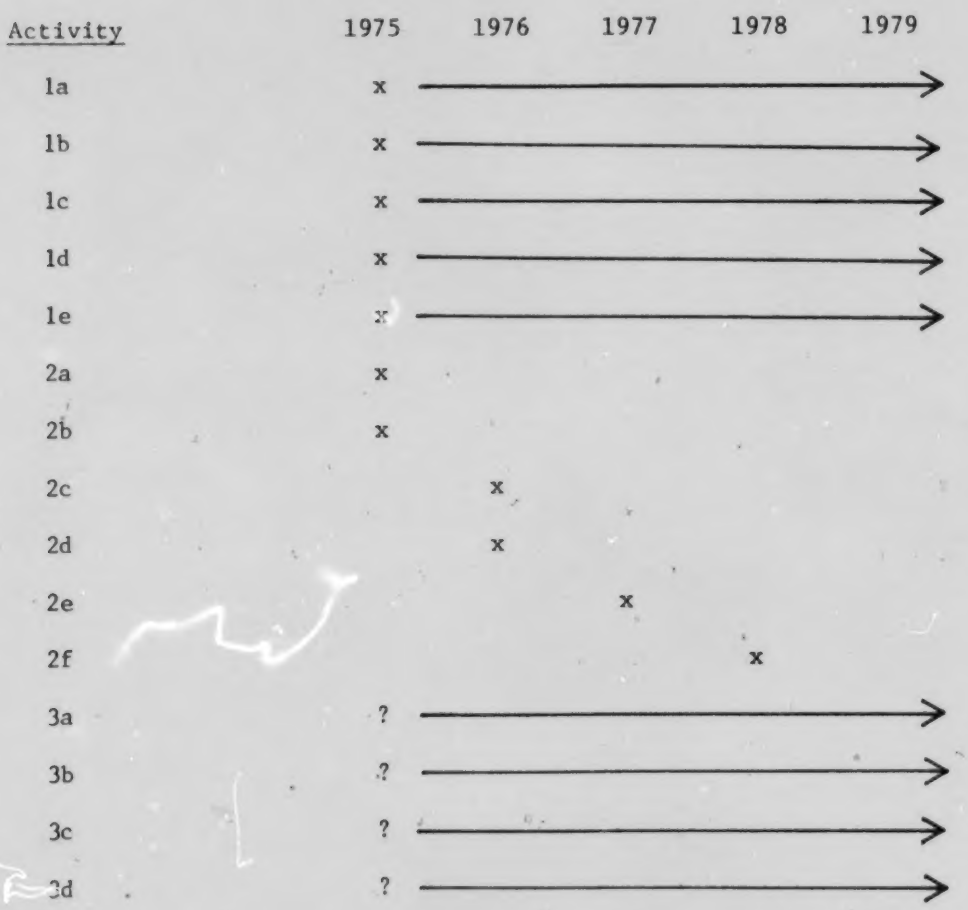
(c) Begin a study to project the need for postsecondary education in the states of the region, and identify where existing programs are in relation to that need, in both qualitative and quantitative terms.

(d) Define a plan for demonstrating the intended self-sufficiency of the UMA consortium, including what assumptions are made about that sufficiency.

(e) Gather market (clientele) information which identifies areas of need for educational experiences that do not exist, and estimate the number and judged quality of courses required to serve those needs. (Note: This activity would assume a targeted population like registered nurses, pesticide operators, etc.)

(f) Construct demand curves which show the optimal tuition rates for courses for which the tuition rate is flexible.

Proposed Schedule of Cost-Effectiveness Studies
Planned for the Five Year Development Period



ABSTRACT: Thoughts on Learning Effectiveness Comparison Studies

by

Dennis D. Gooler

The author questions the intent and viability of comparison studies which attempt to assess learning effectiveness. Is the intent of comparison studies to help curriculum developers who want explanations of why something does what it does, or is the intent to help curriculum selectors choose from among alternative curricula? The author argues that the primary purpose for conducting comparison studies within the SUN program is to inform curriculum selection efforts, not to revise specific courses. In general terms, this means that learning effectiveness comparison studies should seek to determine what works best, for whom, and under what conditions. More specifically, comparison studies should attempt to identify teaching and learning variables which are most critical, to examine alternative forms or structures of those variables, and to predict optimum states of those variables with the SUN program.

The viability of learning effectiveness comparison studies is dependent on answers to both conceptual and methodological issues. One critical issue is the basis upon which comparisons of curricula are to be made, e.g., achievement, appeal, retention, transfer, difficulty, transportability. A second main issue is the course characteristic to focus on. Comparison studies could focus on such course characteristics as developmental approach, format, content, and/or goals. It is recommended by the author that UMA/SUN concentrate on longitudinal studies which attempt to compare course characteristics and impact on learners. The results of such studies should help to select curricula which optimize the intended outcomes.

ABSTRACT: Economic Analysis of the UMA/SUN Open Learning System

by

Richard Attiyeh and Keith Lumsden

This paper focuses on the economic viability of the UMA/SUN open learning program. To address the topic, the authors employ the concepts of optimization, social benefit, and social cost. The economic model assumes that the objective of the open learning program is to maximize net social product, defined as the difference between the total social benefit derived by society and the total costs borne by society as a consequence of the open learning program's operations. Furthermore, the authors assume that social benefit can be measured in dollar terms and that no significant external benefits obtain.

For the UMA/SUN open learning program to be worth establishing, the authors argue, the anticipated social benefits must at least equal the expected social costs. Given that the fixed costs of the open learning program are substantial, economic viability will necessitate a large enrollment of students. How large an enrollment is required is dependent at least on the number of courses offered, the number of learning centers in operation, the frequency of course offerings, the subject matter of courses, the quality of courses, and the student tuition rate. The demand (enrollment) in open learning courses is probably related to the above variables, in addition to the size and age distribution of the population, the income level of students, the location of students, amount of "leisure time," alternative educational opportunities, and previous education.

What the authors have set in motion is a chicken and egg problem. On the one hand, to get student enrollment one must have a desirable program. Yet, the characteristics which make the program desirable also contribute to its major costs. The solution to this dilemma is labeled "rational decision making" by the authors. The goal of rational decision making is to optimize the value of variables such that the difference between the total social benefit and the total social costs is equal, or such that the net social product is zero.

To practice optimization the decision maker requires information which helps him to know (a) how to rank the importance of alternative possible outcomes for the target variables; (b) how changes in the decision variables will affect the target variables; and (c) what range of values for the decision variables are feasible or permissible. Presumably, it is the purpose of cost-benefit studies to provide decision makers with solutions to these problems.

What evidence do the authors bring forth on the economic viability of the UMA/SUN program? To render an opinion on this question the authors consider (a) fixed and variable costs of the UMA course development and the SUN delivery system under various conditions of number of courses offered, number of learning centers, and student enrollments, and, (b) cost comparisons with the British Open University (BOU) and public conventional colleges and universities. The authors conclude that the UMA/SUN program is projected to be very competitive with even the least costly segments of higher education and that the cost structure of UMA/SUN and the BOU are very similar.

The final section of the paper discusses the social benefit issue and the need for research and experimentation by UMA/SUN.

ABSTRACT: A Review of the Context of Cost Analysis

by

Philip Doughty

This paper provides both a conceptual framework and a review of the literature for examining issues related to cost-effectiveness analysis in higher education. The author draws upon the disciplines of economics, operations research, and instructional development to construct his views. Cost-effectiveness analysis is discussed as a type of systems analysis, to be differentiated from cost-benefit analysis, unit cost analysis, cardinal weighting analysis, ordinal ranking, and best guess decision making. What each of the types of systems analysis have in common is a systematic comparison of alternatives, in quantitative and/or qualitative terms, using logical sequences that can be retraced and verified. What differentiates cost-effectiveness analysis from the other types of systems analysis is the method used in the comparison of alternatives.

Cost-effectiveness studies may be designed to serve top level decision makers, or the several levels of program staff. The level of cost-effectiveness analysis should be geared to the users of the data. Furthermore, users of cost-effectiveness data may be interested in the functions of control, planning, evaluation, and/or development. The level of analysis, as well as the function(s) to be served, should indicate whether the general purpose of the study is description, prediction, or comparison. The authors describe each of the three general purposes of cost-effectiveness studies, as well as the two approaches (fixed effectiveness; fixed cost) to the comparison of alternatives. Preliminary feasibility analysis can lead to a tentative determination of the level, function, purpose, and approach for cost-effectiveness studies. The identification of constraints and capabilities serve as the focus for feasibility analysis, and should be reported in the documentation of cost-effectiveness studies.

The author describes in detail "models" for assessing cost and effectiveness. Program budgeting is contrasted with traditional budgeting; cost considerations such as inheritance, research and development, and time are discussed; cost categories are defined; and, cost estimating relationships are introduced. Recent studies using cost analysis models in higher education are reviewed under the headings of jurisdictional costs, functional costs, problems with cost, predictive costs, and comprehensive approaches. A resource allocation model as well as Rand Corporation's MODIA (A Method of Designing Instructional Alternatives) are also identified. Effectiveness models are discussed with reference to the problems of evaluative criteria and prediction.

The author concludes that there is no lack of theoretical models for systems analysis, and that large comprehensive management information systems are in various stages of development and will provide information for high level decision makers. However, the author advises that management information systems are generally not designed to provide information for use in making instructional design and development decisions, and that cost and effectiveness analysis procedures need to be developed to provide data appropriate for course, unit, and module level decisions. The author closes with the recommendation that better procedures are needed for relating costs, effectiveness, and feasibility considerations for both ongoing and projected instructional alternatives.

ABSTRACT: Cost-Effectiveness Analysis Alternatives for Open Learning Programs

by

Philip Doughty

Planners of cost-effectiveness studies within UMA/SUN are faced with several competing considerations, according to the author. One consideration is the selection of variables which are likely to impact on quality and effectiveness. Indicators of quality may be identified from several viewpoints: from that of the psychologist, content specialist, producer/director, instructional developer/evaluator, or student. The author concludes that design, development, production, and operation (delivery) costs for UMA/SUN are influenced by such variables as: length and quality of video production; amount and difficulty of required readings; number and types of assessment procedures; and, amount of student contact with learning centers.

A second consideration facing the planner of cost-effectiveness studies is where to invest limited resources for such studies. The author suggests four areas as prerequisites for cost-effectiveness analysis: (1) proper analysis of costs for development and operation (delivery); (2) assessment of needs; (3) specification of objectives; and, (4) design of assessment procedures.

A third consideration is whether or not to examine the cost-effectiveness of extant instructional resources, for the purpose of acquisition decisions. The author offers the caveat that low-cost acquired courses may result in high-cost operations (delivery) of those courses. Long-range implications of course acquisition could be a focus for cost-effectiveness studies.

A fourth consideration for those who plan cost-effectiveness studies is the extent to which clientle of open learning programs create benefits or costs for other programs. Cost-effectiveness studies could concentrate on benefits derived for existing (conventional) programs, the social benefit derived for a community or state, or the benefit which an individual derives from alternatives among several progrmas. Again, the author offers the caveat that the immediate goal for an innovative, technology-based program that requires support from conventional institutions would be: (a) to serve learners not currently being served by conventional institutions, and to document who those learners are and the benefits that they derive from the program; and, (b) to demonstrate benefits accruing to existing programs which outweigh the costs.

The final section of the paper raises questions pertinent to cost-effectiveness analysis for UMA/SUN.

PRELIMINARY COST-EFFECTIVENESS CONSIDERATIONS FOR UMA/SUN

Working Paper No. 4

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PRELIMINARY
COST-EFFECTIVENESS CONSIDERATIONS
FOR UMA/SUN

Introduction

In a time of declining enrollments, increased costs, faculty terminations, and a general lack of growth, any program which emerges as a new effort in post-secondary education will surely undergo more than the usual critical scrutiny from a range of interested publics. In previous decades, innovations were welcomed, largely because there was sufficient resources for anyone in higher education. An "add-on" view of economics prevailed: if we have need for new resources to do something, let's create new resources.

The times are different now. If new programs are to begin, or, indeed, if old programs are to continue, we must proceed under a policy of resource reallocation, not add-on. Consequently, there is renewed interest in notions of the relationship of cost to effectiveness. And many in higher education are unfamiliar with such thinking.

SUN is rightfully regarded as a major new effort in postsecondary education. Because the program was born in an era of economic difficulties in higher education in general, there was good reason to raise questions about the role of this new program in the overall educational picture in Nebraska (and the UMA region), about the economic impact of SUN on other institutions, and of the cost-effectiveness of SUN itself.

There were and are many important political questions about the existence of SUN. These questions must eventually be carefully and thoughtfully addressed. But so too must some very basic economic questions be addressed: What does it cost to provide educational services to adults through SUN? How do those costs compare to costs of other educational institutions?

Hopfully, decisions about the worth of an educational enterprise should not be made solely on the basis of cost, but will equally consider questions of effectiveness. Whether something is worth the cost depends on what you get for that cost. Too often, the effectiveness part of cost-effectiveness is ignored. Effectiveness data seem more elusive, less amenable to rigorous collection or interpretation. In the case of SUN, however, effectiveness determination is extremely important. Cost factors alone, while necessary in deliberating the future of the program, are not sufficient.

It may be helpful to think about cost-effectiveness in SUN in two ways: internal cost effectiveness (what is the relative cost and effectiveness of alternative kinds of courses or course development procedures?); and external cost-effectiveness (how cost effective is SUN compared to the University of Nebraska-Lincoln, or compared to the British Open University?). Both kinds of questions are relevant.

One of the 1974 NIE work assignments appears to address questions of internal cost-effectiveness. The work assignment reads:

> Develop a plan for the use and evaluation (including cost and learning effectiveness comparison studies) of at least four different approaches to courseware development. These are to include (a) (12 month) high-production-quality, high-cost TV programming; (b) (9-month) low-cost TV programming; (c) (6 month) adaptations of existing television programming; (d) (9 month) non-television, other media programming.

The work assignment was correct in recognizing that courses in SUN might be developed in a variety of ways. Two things were important in that recognition: some ways of developing courses will inevitably be more expensive than others; and, no one really knows what approaches to courseware development and, more importantly, what kinds of courses, will result in more or better learning on the part of enrolled adults.

While the work assignment thus correctly pointed to a number of extremely important questions, the assignment was also clearly inadequate in its assumptions about the way in which the questions ought to be thought about. Therefore, the work undertaken during 1974 on this assignment focused largely on clarification of what the issues really are in this area of cost-effectiveness.

This chapter describes SUN efforts to address the NIE work assignment, with particular emphasis on how to think about effectiveness, and how to subsequently relate effectiveness to cost. It should be pointed out that the work assignment called for developing a plan for conducting cost and learning effectiveness comparison studies, not for actually conducting those studies.

This paper contains three sections. Following this introduction, the procedures used to conduct the planning suggested by the work assignment are outlined. Next, the papers developed in the planning process are identified. Finally, a plan for future cost-effectiveness work by UMA/SUN is set forth.

We recognize that only a beginning has been made in this area. Hopefully, this is an appropriate beginning to an intelligent and thoughtful analysis of the cost-effectiveness of UMA/SUN.

Procedures Used in the Planning of Cost-Effectiveness Studies

The first attempts to plan for the kind of comparison studies of courseware development suggested by the work assignment were aimed at questioning the intent and viability of such studies. The Office of Research and Evaluation drafted an initial statement on learning effectiveness comparison studies, and the Office of Business and Finance contracted with The Esmee Fairbairn Economic Research Center (TEFERC) for a paper on the economics of the open learning program. It was the intent, at that point, to approach comparison studies from both the cost perspective and the effectiveness perspective.

The statements resulting from this work were reviewed by SUN staff to assess the kinds and quantities of comparison studies which would be both desirable and feasible starting in 1975. The staff found that these initial statements on learning effectiveness and cost comparison studies were suggestive rather than conclusive in specific recommendations for 1975 and beyond, and thus required additional work.

First, a review of the literature was initiated to identify pertinent issues and studies of cost-effectiveness in postsecondary education. Staff in the Office of Research and Evaluation discovered that a similar review had already been accomplished by Dr. Philip Doughty of Syracuse University. The major objectives of the Doughty review were: (a) to identify and examine assumptions which underlie systems analysis as an aid to decision makers; (b) to view assumptions within a given educational setting; (c) to review existing applications of cost analysis in various educational contexts; and (d) to consider the design of a generic cost analysis process model for use by inservice and preservice teacher educators. Although the Doughty report focused on cost analysis and teacher education, it served as a reference for representative models and issues in cost-effectiveness analysis in higher education in general. It was the judgment of the staff that the Doughty review of the issues and literature was comprehensive and well organized. Therefore, rather than invest additional resources to produce a similar statement, the Office of Research and Evaluation made arrangements to reprint the Doughty review as a "state of the art" paper in cost-effectiveness analysis.

The next step taken was to identify issues of cost-effectiveness analysis particularly relevant to open learning and UMA/SUN. Of the large range of issues in cost-effectiveness analysis which UMA/SUN could address, some judgment had to be made about what issues would be most profitable to invest in. To help in this

judgment, and with a background in both the theory and the practice of cost-effectiveness analysis, Philip Doughty was asked to prepare a brief paper which would identify cost-effectiveness analysis issues pertinent to UMA/SUN and open learning. That paper was prepared and reviewed by SUN staff.

The paper itself was seen as one vehicle to inform SUN staff of the issues and options for cost-effectiveness analysis. A second part of the strategy was to meet with Dr. Doughty in a seminar arrangement, whereby SUN staff could raise questions and probe into the application of cost-effectiveness analysis. This meeting was seen as important, in that staff outside the Office of Research and Evaluation are the primary internal users of cost-effectiveness studies and might profit from an examination of the issues therein. The seminar with Dr. Doughty was well attended, having representatives from all office areas in SUN. Although the specific issues discussed at that seminar are not reported here, it was felt by SUN staff that Dr. Doughty had identified some of the important implications in cost-effectiveness analysis for UMA/SUN, and that a specific plan should be drafted to address these concerns. The plan for cost-effectiveness studies reported in the final section of this paper draws heavily on the results of the seminar with Dr. Doughty.

The Office of Research and Evaluation has also made a start into the analysis of course costs. In that cost-effectiveness studies require the proper analysis of development and delivery costs, staff from both the Office of Business and Finance and the Office of Research and Evaluation have worked cooperatively (a) to begin to identify the student and course costs for the first two courses developed and delivered by SUN, and (b) to locate areas where cost data are not available in sufficient detail to make certain descriptions and comparisons. It is anticipated that future work in cost-effectiveness analysis will involve both Offices.

Papers Developed in the Planning Process

During the 1974 calendar year, four main papers were developed in the considerations of cost and learning effectiveness comparison studies. The four papers are:

1. Thoughts on Learning Effectiveness Comparison Studies - Dennis D. Gooler, Director, Office of Research and Evaluation, State University of Nebraska.

2. Economic Analysis of the UMA/SUN Open Learning System - Richard Attiyeh and Keith Lumsden, Associates, The Esmee Fairbairn Economic Research Center.

3. A Review of the Context of Cost Analysis - Philip Doughty, Assistant Professor, Department of Instructional Technology, Graduate School of Education, Syracuse University.

4. Cost-Effectiveness Analysis Alternatives for Open Learning Programs - Philip Doughty, Assistant Professor, Department of Instructional Technology, Graduate School of Education, Syracuse University.

The four papers, and an abstract of each, are found in the Appendices of this report.

A Plan for UMA/SUN Cost-Effectiveness Studies

The two main questions addressed in this section are: (1) Should UMA/SUN engage in systematic cost-effectiveness studies; and, (2) If so, what kinds of studies should be undertaken?

Should Cost-Effectiveness Studies Be Undertaken?

The rationale for UMA/SUN engaging in cost-effectiveness studies appears to be compelling for at least five reasons. First, the sponsors of UMA--NIE, foundations, and affiliates--must judge the worth of their investment in the enterprise. UMA will probably be judged on the basis of its viability as an organization which is distinct from existing agencies and which contributes to

the educational and general health of the region. UMA will also probably be judged on the efficiency of the products it produces and the services it renders. Also, UMA will probably be judged on the benefits and costs which UMA products and services create for individuals, communities, and institutions. Thus, given that other agencies are competing for funds from the sponsors of UMA, it behooves UMA to be prepared to defend its program in terms of distinction, efficiency, and benefits. Comparisons will be made among competing investments; data and information generated by UMA could be influential in those comparisons.

Second, the SUN (and other affiliates of UMA) will probably be required to seek some level of state support, at least during the next five years. This, in turn, means competition with other state agenices for funding; it also means that for some state agencies SUN will be a threat to their funding base. Furthermore, SUN may be a threat to the "market" which existing institutions serve. It would be to SUN's advantage if it could demonstrate: (a) benefits which accrue to other agencies as a result of SUN's operation; (b) that its clientele are not being served by existing programs; (c) that definite individual and community benefits result from SUN; and, (d) that where credit is offered, the courses are academically sound and produce the intended results. The climate for SUN will be influenced by other institutions in the state, and how the state legislature recieves SUN. Studies which address the concerns of both advocates and opponents of SUN would be beneficial in developing a positive climate for the growth of SUN.

Third, the students of SUN (and other state affiliates of UMA) must make judgments about the worth of obtaining educational experiences and services which are offered. Given competing demands, it must be clear that SUN is an opportunity which addresses the interests of its target population. Information about how SUN, and other state affiliates of UMA, helps students meet their

personal goals would be advantageous. It would also be helpful to document how SUN is responsive to the needs of the population which it serves, and what those needs are. The tuition rates for SUN courses must also be compatible with students willingness or capabilities of paying. One of the premises for the UMA/SUN program is that sufficiently large numbers of student-clients will create economies of scale. Both the number of students and the rate of tuition will impact on the economic viability of SUN.

Fourth, the top level decision makers in UMA/SUN require timely and trustworthy information for internal decisions. For example, decisions must be made about the acquisition of courseware, either to be modified or accepted without change. Cost-effectiveness studies could help to identify results obtained in previous use of a course, as well as initial and long-range cost implications of courses acquired for use in UMA states. A second kind of internal decision is the recommendation to the Academic Council for a course to be developed or acquired. In this case not only the potential "market" for the course, but also projected course cost and effectiveness data, would be beneficial. Also, given that some flexibility exists in setting tuition rates, cost studies could help to construct demand (enrollment) curves which relate tuition to enrollment patterns under given conditions of course content, quality, and/or services.

Fifth, staff in UMA/SUN (e.g., instructional designers, producers, learning center coordinators) make decisions about specific content, instructional strategies, uses of media, course structure, and student services. If course cost and/or effectiveness data were available at the appropriate time, staff could use such data as a resource in their decisions.

Although these five reasons serve as support for the conduct of cost-effectiveness studies, the undertaking of such studies must also be judged

in relation to competing activities within the organization. Each office within UMA/SUN has ongoing activities slated for next year, to which added cost-effectiveness studies might be a burden. Furthermore, it is not entirely clear what the results of cost-effectiveness studies would be (in terms of specific data), or how that data would be used in the decision making process. In short, there are some unknowns about how costly, effective, and beneficial cost-effectiveness studies might be. However, for the reasons given above, it is recommended that UMA/SUN undertake a few strategic studies which over time could address the issues raised in this report.

What Kinds of Cost-Effectiveness Studies Should be Undertaken?

It is recommended that the criteria for selecting cost-effectiveness studies to be undertaken by UMA/SUN recognize major areas of vulnerability to the organization, and honor a proactive rather than reactive approach to such studies.

One major source of vulnerability for UMA/SUN is its dependence on external funding during the five year development period. Although projections have been made that operational aspects of UMA and affiliates could be self-supporting after the five year development period, there is no guarantee that outside funding will be extended throughout the first five years. To increase the probability that outside funding is obtained over the developmental period, an ongoing dialogue and information flow should continue with present and potential funders, as well as institutional leaders. The recipients of information should include program directors in NIE, other governmental offices, and foundations; state legislatures and their committees; and, heads of existing institutions. The objective of such dialogue and information flow would be threefold. One objective would be to adequately and accurately represent the status of UMA and its affiliates. A second objective would be to address issues of importance

to decision makers in outside agencies, including issues such as who UMA and its affiliates serves and who it does not serve, how UMA and affiliates overlap with and are distinct from existing programs, projected plans over the next five years, the projected impact on existing institutions, and contributions which UMA and affiliates are making to existing institutions, communities, and individuals. A third objective would be to carefully identify the support base which UMA and affiliates require over the next five years, the rationale for it, and the plans for financing UMA and affiliates after the five year developmental period.

Internal to the organization, one major source of vulnerability is the lack of communication and coordination across offices. Quality, or effectiveness, is not a univariate concept; neither is cost. All of the offices and individuals in UMA/SUN contribute to both the quality and cost of the enterprise. To the extent that cost and effectiveness information can be used in decisions to select particular instructional strategies, media, and intended outcomes, the organization should be less vulnerable from within.

To address these concerns, it is recommended that the following cost-effectiveness analysis activities be undertaken by UMA/SUN over the next five years. The activities are ordered with respect to (1) activities which should become a part of routine data collection; (2) activities which should be targeted for 1975 and beyond; and, (3) activities which go beyond strictly cost-effectiveness analysis, but which are important to consider in judging the impact and cost of the enterprise. A proposed schedule for cost-effectiveness studies over the five year developmental period follows the description of planned activities.

1. Activities which should become a part of routine data collection.

   a. Identify the potential (and actual) clientele of the open learning program and differentiate them, as appropriate, from the clientele of conventional programs.

   b. Document referrals to and enrollments in existing programs which result from advisory services and/or course enrollments in SUN and other UMA affiliates.

   c. Provide consulting services to existing programs to help them sharpen their own program's resources and goals, and document the effect of that consultation.

   d. Share and compare information with institutions through WICHE, Empire State, BOU, and other open learning programs.

   e. Assess courses to be acquired in terms of potential effectiveness and long-range cost implications.

2. Target activities for 1975-1979 (detailed).

   a. Develop descriptive models which portray the costs and effectiveness of courses already delivered.

      (1) Identify and describe per course/per student costs for Accounting I and Introductory Psychology in terms of: (a) design, production, research, evaluation, and delivery; and (b) media employed, i.e., television, text, study guide, newspaper, and audio tapes (Accounting I only).

      (2) Identify and describe outcome measures for Accounting I and Introductory Psychology in terms of (a) unit test data; (b) unit evaluation data; (c) end-of-course evaluation data; and, (d) student interview data.

      (3) Portray cost and outcomes data in a format conducive to cost-effectiveness analysis.

      (4) Predict the costs and outcomes for the second offerings of Accounting I and Introductory Psychology.

   b. Engage in an experimental study with the University of Nebraska at Lincoln (UNL) where Accounting I can be compared in cost and effectiveness to a UNL introductory accounting course on campus.

      (1) Design research study so that proper interpretation can be made of differences in Accounting I and UNL conventional course which result in measured outcomes, including achievement, appeal, and application.

(2) Identify and describe costs associated with the experimental (SUN Accounting I) and control (UNL introductory accounting) courses, including all relevant assumptions.

(3) Describe in detail the experimental and control groups, as well as the process ("treatment") administered.

(4) Portray cost and outcomes data and present in a format conducive to cost-effectiveness analysis.

(5) Draw conclusions from the study, including the methodological and practical constraints and the value of the data to decision makers.

(6) Report findings of study to UMA/SUN and UNL parties.

c. Conduct a feasibility study to determine what information needs exist in course development and delivery and how data on either cost or effectiveness would make a difference.

(1) Interview development and delivery staff to identify specific decisions made in selecting (a) course goals; (b) instructional strategies; (c) media; (d) assessment procedures and instruments; and (e) services offered to students.

(2) Describe both actual and potential data used in specific development and delivery decisions.

(3) Identify and describe the constraints and capabilities which exist for development and delivery.

(4) Draw conclusions about the desirability and feasibility of providing cost and/or effectiveness to staff in the development and delivery of courseware and services.

(5) Identify at least one course to experiment with staff on the generation and use of cost-effectiveness data.

d. Document the costs of existing programs and the assumptions to be used in comparing conventional program costs with open learning program costs.

(1) Select at least three UMA/SUN courses (one UMA-developed, one UMA-adapted, one UMA-acquired) for cost comparisons with other institutions.

(2) Identify at least one each of the following institutions for cost comparisons with the above three courses: an open learning program (e.g., Empire State or The BOU); a 2-year community college; a 4-year college; a university.

(3) Describe assumptions for cost comparisons and analyze course costs by institution.

(4) Draw conclusions about the relative cost of UMA/SUN courses when compared with other institutions.

(5) Report findings of the study, as well as implications for the operation of UMA/SUN.

e. Analyze the cost and effectiveness data from approximately ten UMA/SUN courses in terms of goals, media, unintended consequences, and unanticipated results.

(1) Across the ten course contents, identify level of course goals to be realized (objectives) and identify course costs and effectiveness data by level of course objectives.

(2) Construct a typology of media employed across the ten courses and identify course costs and effectiveness data by types of media employed.

(3) For each of the ten courses, describe the unintended costs and/or effects of the course.

(4) For each of the ten courses, describe the unanticipated positive and negative results from the course.

(5) Portray the cost and effectiveness data across the ten courses in terms of goals, media, unintended consequences, and unanticipated results.

(6) Draw conclusions as appropriate from the comparisons.

f. Select at least one course in which to experiment with different media, and seek to determine the impact of those media on course costs and effectiveness.

(1) Develop one body of course content with specified goals, assessment procedures and student services, in at least three media combinations: (a) print only, (b) nonprint only, and (c) print and nonprint.

(2) Following rigorous experimental design procedures, randomly assign subjects (students) to each of the three experimental forms of the course. Also, employ a control group which is not subjected to any of the three treatments.

(3) Document course costs as well as outcomes, using the same assessment procedures.

(4) Portray the costs and outcomes data in a format conducive to cost-effectiveness analysis.

(5) Draw conclusions from the study and identify implications for media selection in the particular content area.

(6) Identify what generalizations, if any, apply to other content areas, course goals, and assessment procedures.

(7) Critique the worthwhileness of the study, including if additional inquiries of this type are productive.

3. Activities which go beyond cost-effectiveness analysis, but which are important to consider.

(a) Begin a baseline study of the impact of UMA-SUN on existing institutions, including impact on (1) student enrollments; (2) faculty; and (3) services and programs.

(b) Begin a baseline study of the impact of UMA-SUN on the communities in states in the region.

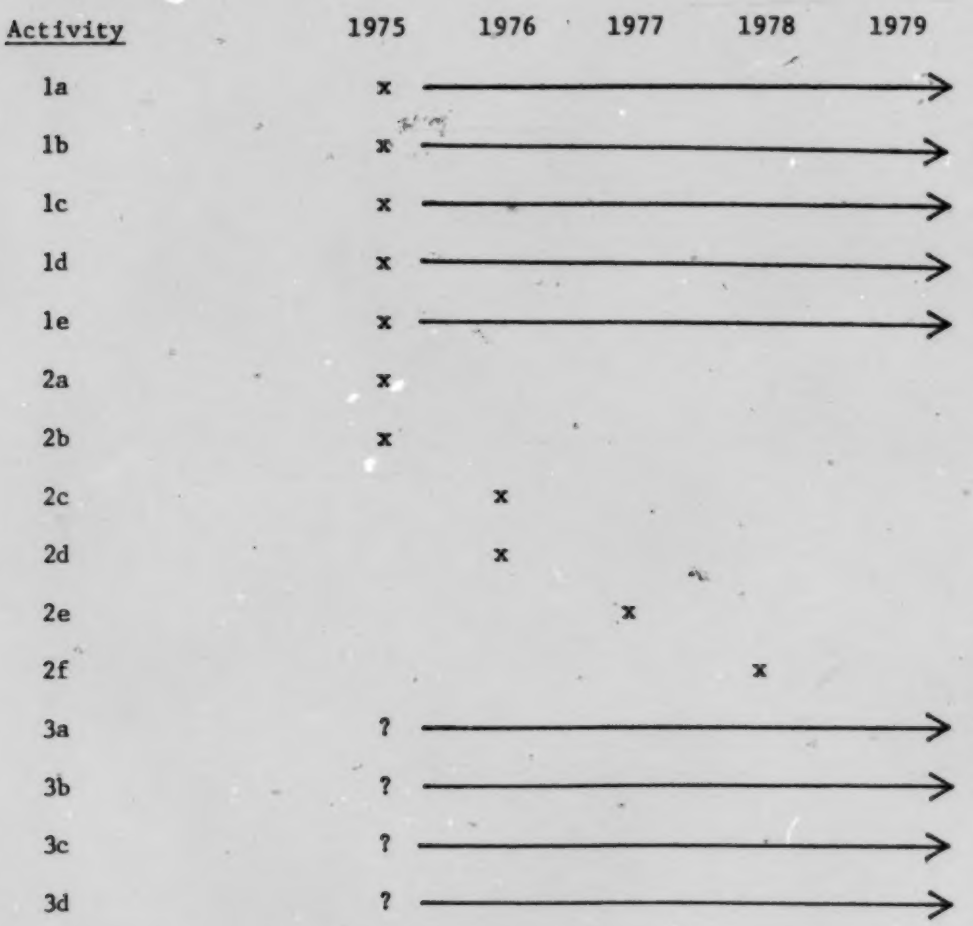
(c) Begin a study to project the need for postsecondary education in the states of the region, and identify where existing programs are in relation to that need, in both qualitative and quantitative terms.

(d) Define a plan for demonstrating the intended self-sufficiency of the UMA consortium, including what assumptions are made about that sufficiency.

(e) Gather market (clientele) information which identifies areas of need for educational experiences that do not exist, and estimate the number and judged quality of courses required to serve those needs. (Note: This activity would assume a targeted population like registered nurses, pesticide operators, etc.)

(f) Construct demand curves which show the optimal tuition rates for courses for which the tuition rate is flexible.

Proposed Schedule of Cost-Effectiveness Studies
Planned for the Five Year Development Period



Appendix A

Thoughts on Learning Effectiveness Comparison Studies

by

Dennis D. Gooler

April 1974

ABSTRACT: Thoughts on Learning Effectiveness Comparison Studies
by
Dennis D. Gooler

The author questions the intent and viability of comparison studies which attempt to assess learning effectiveness. Is the intent of comparison studies to help curriculum developers who want explanations of why something does what it does, or is the intent to help curriculum selectors choose from among alternative curricula? The author argues that the primary purpose for conducting comparison studies within the SUN program is to inform curriculum selection efforts, not to revise specific courses. In general terms, this means that comparison studies should seek to determine what works best, for whom, and under what conditions. More specifically, comparison studies should attempt to identify teaching and learning variables which are most critical, to examine alternative forms or structures of those variables, and to predict optimum states of those variables with the SUN program.

The viability of learning effectiveness comparison studies is dependent on answers to both conceptual and methodological questions. One critical question is the basis upon which comparisons are to be made, e.g., student achievement, appeal, retention of learning, difficulty, transportability, etc. A second major question is the course characteristic to focus on. Comparison studies could focus on such course characteristics as developmental approach, format, content, and/or goals. It is recommended by the author that UMA-SUN concentrate on logitudinal studies which attempt to compare course characteristics and impact on learners. The results of such studies should help to select curricula which optimize the intended outcomes.

GRS

S-U-N
Office of Research and Evaluation
April, 1974

THOUGHTS ON LEARNING EFFECTIVENESS COMPARISON STUDIES

Dennis D. Gooler

One of the NIE work statements (Work Assignment 2) for 1974 concerns the development of a plan "for the use and evaluation (including cost and learning effectiveness comparison studies)" of a variety of approaches to courseware development. A number of questions might be posed as to the intent and viability of that work statement. While similar questions might be raised about the cost elements of the work statement, this paper focuses upon the learning effectiveness concerns of that statement.

It is first reasonable to ask about the purposes for planning and conducting comparison studies of the kind implied by the work statement. To answer this question requires clarification as to whether the intent is to understand why a given curriculum or course does what it does, or to choose from among alternative curricula. Cronbach (1963), for example, criticizes the comparative method of evaluation:

> In an experiment where treatments differ in a dozen respects, no understanding is gained from the fact that the experiment shows a numerical advantage in favor of the new course. No one knows which of the ingredients is responsible for the advantage.

Scriven (1967), however, looks at the issue from a different perspective. He argues that

> understanding is not our only goal in evaluation. We are also interested in questions of support, encouragement, adoption, reward, refinement, etc. And these extremely important questions can be given a useful though in some cases not a complete answer by the mere discovery of superiority.

Glass (1972) argues that Scriven and Cronbach are speaking at cross purposes here. For the curriculum developer, the question of explanation, or why something does what it does, is of critical importance. To the curriculum selector, however, comparative data showing the relative effectiveness of competing courses or curricula may be of much greater usefulness for the kinds of decisions he must make. As a conclusion to his remarks, Glass makes the following observation:

> The message here is that the curriculum developer wants to know how and why his materials function as they do and that he will not make good use of comparative data. However, comparative evaluation at some level is necessary. The anarchist who opposes all comparisons of curricula in favor of determining which objectives are met by which students and why, has forgotten that an implicit comparison is present in establishing the objectives of any curriculum. No one is foolish enough to establish the objective for a curriculum in typing of "typing 10 words per minute with no more than 5 mistakes" because existing curricula are already superior to this. At some point in the evaluation of a curriculum these implicit comparisons must be revealed and subjected to a test.

Where does S-U-N fit into all of this? At the most general level, S-U-N might consider conducting comparison studies to determine what works best, with whom, and under what conditions. More specifically, S-U-N is interested in identifying those variables in teaching and learning which are most critical, and to examine alternative forms or structures of those variables in an effort to predict optimum states of those variables within the S-U-N program. This identification would potentially lead to maximum instructional effectiveness, while minimizing untoward side effects, such as excessive cost or negative learner affect. In essence, S-U-N is faced with both the curriculum development problems and the curriculum selection problems alluded to by Glass.

It is possible to ask questions about effectiveness within a given course: were the course objectives realized? Did students learn what was intended?

In short, did the course work? Comparative studies introduce another dimension: Did (or will) Course A work as well as, better, or worse than Course B? Comparison requires that a given course be analyzed in terms of or in relation to another course, not exclusively in terms of its own intents. S-U-N may pursue both comparative and non-comparative studies: the intent of those studies must be clearly understood at the outset.

I would argue that the primary purpose for conducting comparison studies within the S-U-N framework is to inform future selection efforts, not to revise or modify the specific courses being compared. That is, I believe that the things learned from certain comparison studies will be instrumental in developing guidelines for either selecting and adapting extant courses for the S-U-N curriculum, or selecting instructional techniques or objectives for future S-U-N courses.

While many conceptual and methodological questions might be raised concerning comparative studies, one stands out as critically important: on what basis shall comparisons be made? Shall courses be compared on the basis of relative student achievement? On cost? On appeal? On retention of learning? On ease of administration? On difficulty? On transportability? Each of these kinds of outcomes is significant, and may be important for different purposes. What is essential in any comparative study is some agreement upon the criteria, or variables, whereby the courses being compared are to be analyzed and subsequently judged. Most often, comparative criteria will be multiple. Student achievement has always been regarded as a paramount criterion, but other criteria may be equally important, depending on the purpose for making the comparison.

Given this brief background, it is possible to describe at least four ways in which comparison studies in S-U-N might be conceptualized:

1. Holding the content and goals of a given course constant, and also agreeing upon a relevant outcome measure appropriate for all forms of the course, it is possible to vary developmental approach. For example: Suppose S-U-N wishes to create a course in introductory sociology. If the basic goals and objectives for that course are agreed upon as appropriate to the course, it is possible to compare different developmental versions (See Appendix A) of the course with respect to learner achievement. In so doing, it would be possible to suggest which of the course types seemed to produce the greatest learning. It would not be possible to identify which of the elements of a given course type was responsible for differences in achievement, but it would be possible to specify which type, in the aggregate, seemed to work best, according to the achievement variable. The inability to describe in very precise terms the cause of differentiated outcomes (for example, was it the inclusion of high quality, high cost color television segments that made the difference?) might render this kind of comparative study less than useful, until or if a series of such studies pointed up the consistent advantage of a certain course type.

2. A second kind of comparative study would hold constant the content and objectives of a course, as well as the criterion measure, but would vary the format or structure of the course. For example: suppose the content was in economics, course goals were agreed upon,

and an achievement examination was developed to the satisfaction of those involved. Several versions of the course were then prepared, in which: in one version, learners read the text, then viewed the television, then worked a series of problems, then utilized audio cassettes. In another version, learners first viewed the television segment, then worked problems, listened to the audio tape, and finished by reading the text. Still another version might be prepared, with another instructional sequence. Students in each version are tested, and the results compared.

It is also possible to conduct attrition comparison studies. That is, a complete course might be developed, containing all of the elements potentially part of a S-U-N course (television, audio tapes, syllabus, work books, computers, etc.). In one version the entire course, with all elements, is offered to learners. In a second version, one or more of the elements is deleted. Achievement results are compared in an effort to find out which aspects of a given course appear to contribute to learning outcomes.

There are a number of other comparisons of this kind that might be made. The use of authority figures, for example, might be explored. Embedded testing might be examined. Each of these kinds of comparative studies would be conducted in an effort to isolate the nature and kind of instructional elements that seem to make a difference in learning outcomes. This kind of study appears to be a unique application of the notion of comparison.

3. There is a third kind of comparative study that might be conducted, in an attempt to understand the relationship between a particular course format, and the content to which it is addressed. That is, holding course format constant, and varying content, do differential learning outcomes occur? For example: in a carefully prescribed program of individualized instruction, in which various elements appear in the same order in all versions of the course, does some content appear more amenable to that format than does other content? Will the particular course format work in biology, for example, but not in psychology? The difficulty here, of course, is that achievement or criterion measures are not held constant across courses. It is then difficult to directly compare achievement in biology to achievement in psychology. It may well be that criteria other than achievement will be appropriate in such studies. These observations lead to a fourth kind of comparative study.

4. It may be possible to describe each of a number of course types (different content, different pedogogy, etc.), and to document the extent to which each achieves the objectives stated or appropriate to that course. Course types may thus be "compared" with respect to the extent to which each is successful in accomplishing its ends. Glass has addressed this possibility:

> Carroll claimed that curricula do not ordinarily have identical objectives and that to compare them raises philosophical problems about the comparative worth of different objectives. The choice between two competing curricula with greatly different objectives cannot help but raise philosophical questions, or ethical questions, or at least questions of the relative worth of certain values held by a society. Anyone who must make decisions

> affecting the adoption of curricula or innovative activities for a school is faced with resolving just these questions. I doubt that such questions can be adequately resolved and a rational decision made unless empirical data are gathered which show how well a curriculum attains its own objectives, the objectives of competing curricula, and certain cross-curricular objectives.

Such a comparative approach may require the least amount of obtrusiveness or technical preparation, but would also require the greatest amount of inference in its conclusions. This kind of comparison is possibly most conducive to naturalistic study, to be conducted within limited resources.

Appendix B

Economic Analysis of the UMA-SUN Open Learning System

by
Richard Attiyeh
Keith Lumsden

September 1974

ABSTRACT: Economic Analysis of the UMA-SUN Open Learning System

by

Richard Attiyeh and Keith Lumsden

This paper focuses on the economic viability of the UMA-SUN open learning program. To address the topic, the authors employ the concepts of optimization, social benefit, and social cost. The economic model assumes that the objective of the open learning program is to maximize net social product, defined as the difference between the total social benefit derived by society and the total costs borne by society as a consequence of the open learning program's operations. Furthermore, the authors assume that social benefit can be measured in dollar terms and that no significant external benefits obtain.

For the UMA-SUN open learning program to be worth establishing, the authors argue, the anticipated social benefits must at least equal the expected social costs. Given that the fixed costs of the open learning program are substantial, economic viability will necessitate a large enrollment of students. How large an enrollment is required is dependent at least on the number of courses offered, the number of learning centers in operation, the frequency of course offerings, the subject matter of courses, the quality of courses, and the student tuition rate. The demand (enrollment) in open learning courses is probably related to the above variables, in addition to the size and age distribution of the population, the income level of students, the location of students, amount of "leisure time," alternative educational opportunities, and previous education.

What the authors have set in motion is a chicken and egg problem. On the one hand, to get student enrollments one must have a desirable program. Yet, the characteristics which make the program desirable also contribute to its major costs. The solution to this dilemma is labeled "rational decision making" by th

authors. The goal of rational decision making is to optimize the value of variables such that the difference between the total social benefit and the total social costs is equal, or such that the net social product is zero.

To practice optimization the decision maker requires information which helps him to know (a) how to rank the importance of alternative possible outcomes for the target variables; (b) how changes in the decision variables will affect the target variables; and (c) what range of values for the decision variables are feasible or permissible. Presumably, it is the purpose of cost benefit studies to help inform decision makers with solutions to these problems.

What evidence do the authors bring forth on the economic viability of the UMA-SUN program? To render an opinion on this question the authors consider (a) fixed and variable costs of the UMA course development and the SUN course delivery under various conditions of number of courses offered, number of learning centers, and student enrollments, and, (b) cost comparisons with the British Open University (BOU) and public conventional colleges and universities. The authors conclude that the UMA-SUN program is projected to be very competitive with even the least costly segments of higher education and that the cost structure of UMA-SUN and the BOU are very similar.

The final section of the paper discusses the social benefit issue and the need for research and experimentation by UMA-SUN.

AN ECONOMIC ANALYSIS OF THE UMA-SUN OPEN LEARNING SYSTEM

PREPARED FOR

THE SUN PROJECT
UNIVERSITY OF NEBRASKA

BY

THE ESMEE FAIRBAIRN ECONOMIC RESEARCH CENTRE

SEPTEMBER 1, 1974

AN ECONOMIC ANALYSIS OF THE UMA-SUN OPEN LEARNING SYSTEM

1. AN ECONOMIC APPROACH TO PLANNING AN OPEN LEARNING SYSTEM.

1.1. Optimization

Economic analysis is fundamentally concerned with problems of optimal decision making. Typically the decision maker will have control over certain variables (decision variables) and through this control can influence other variables (target variables) in which he is interested. In deciding what values to choose for the decision variables, the decision-maker must know three things. First, he must know how to rank alternative possible outcomes for the target variables. That is, he must have well defined objectives with respect to the variables he is ultimately trying to influence. Second, he must know how changes in the decision variables will affect the target variables. That is, he must have information about the functioning of the economic system in which he operates. Third, he must know what range of values for the decision variables are feasible or permissible. That is, he must take into account any resource or institutional constraints that limit his choice.

For the planners of an open learning system (OLS) the target variables presumably include such items as the number of students enrolled in OLS courses, the value to them of taking such courses, and the costs incurred in offering courses and enrolling students. The decision variables might include the number, quality and subject matter of courses offered as well as the tuition and fees to charge students who enroll. Since the UMA-SUN OLS is a public institution it is assumed that its objective is the maximization of net social product defined to be the

difference between the total benefits derived by society and the total costs borne by society as a consequence of the OLS's operations. Note that maximization of net social product is not the same as, and does not necessarily imply, maximization of student enrollment in the OLS, or maximization of the quality of its programs, or minimization of the OLS's financial deficit. As will be seen below, however, a decision which maximizes net social product will have definite implications for the optimal enrollment in the OLS, the optimal quality of its programs and the optimal government subsidy. Given this objective, the OLS planners need to determine how benefits and costs can be measured and also how benefits and costs will be affected by changes in decision variables such as the number and quality of courses offered. Finally, any limitations on student enrollment, tuition and fees, financial deficit, etc., which constrain planners in their choice of values for decision variables must be taken into account.

In order to see how this cost-benefit framework can be applied, consider an OLS which offers one course each year in which any person can enroll. Suppose that the annual total social benefit depends on the number of persons enrolled per year in the following way: the higher enrollment is, the greater is total benefit, but the smaller is marginal benefit. (Marginal benefit is the extra benefit which results from a unit increase in enrollment.) Assuming that benefit can be measured in dollar terms, the relationship between enrollment and benefit can be depicted as shown in Figures 1.1 and 1.2.

Figure 1.1

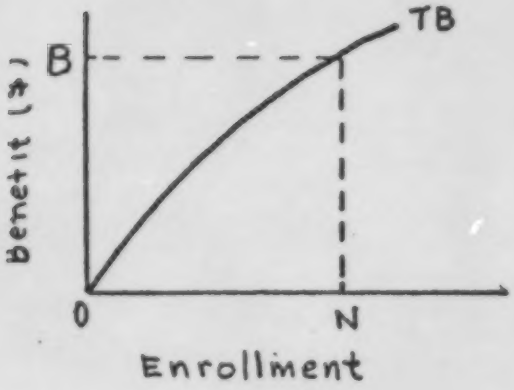
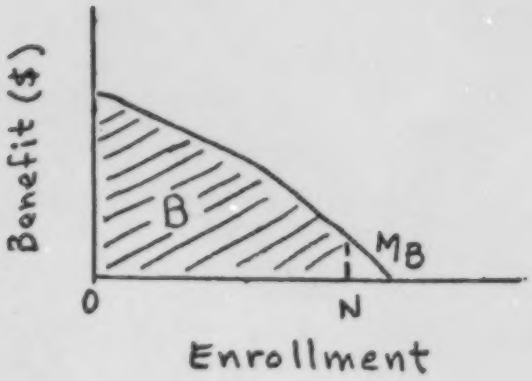


Figure 1.2



This relationship is such that the height of curve TB at any enrollment level in Figure 1.1 is equal to the area under curve MB up to the same enrollment level in Figure 1.2. For example, for enrollment N, the total benefit indicated by the height B of curve TB in Figure 1.1 is equal to the shaded area B in Figure 1.2.

Now suppose that there are two types of social cost involved in offering the course: fixed costs which are independent of the number of students enrolled[1] and variable costs which increase with enrollment.[2]

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1. Items which are fixed costs are the interest and depreciation on the capital investment embodied in the course and any overhead administration, etc.

2. Items which are variable costs are books, grading, registration, counselling, etc.

The relationship between cost and enrollment is shown in Figures 1.3 and 1.4.

Figure 1.3

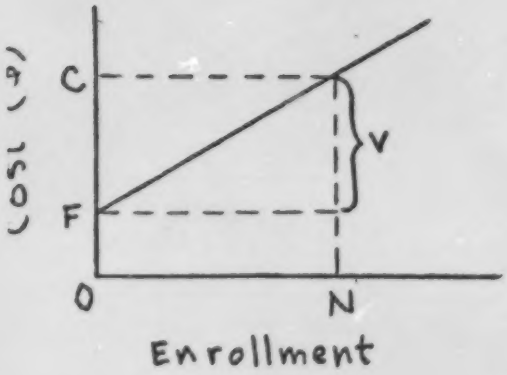
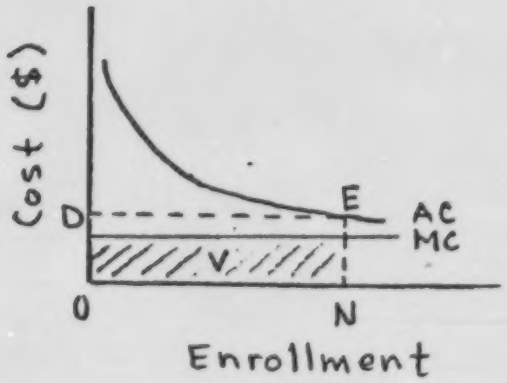


Figure 1.4



At enrollment N, the total cost is indicated by the height of curve TC in Figure 1.3 which is equal to the sum of the fixed cost and the variable cost. The marginal cost, i.e., the increase in cost associated with a unit increase in enrollment, is shown by curve MC in Figure 1.4. MC is a horizontal line because it is assumed that student cost is proportional to enrollment. The area V under curve MC up to enrollment level N in Figure 1.4 is equal to the total variable cost V which equals total cost C minus fixed cost F for enrollment level N in Figure 1.3. The average cost per student is shown by curve AC in Figure 1.4. This curve includes both average fixed and average variable cost. It has a negative slope because the average fixed cost decrease as enrollment increases and given the assumption of constant marginal cost, the AC curve lies above MC for all levels of enrollment and asymptotically approaches the MC curve as N increases. By definition, for any enrollment level, TC = AC x N.

For example, the total cost C in Figure 1.3. is equal to the area ODEN

(average cost D times enrollment N) in Figure 1.4.

By considering benefit and cost in the same diagram it is possible to determine whether this simple OLS should be established and if so what level of enrollment is optimal. In Figures 1.5 and 1.6 these questions are considered for the simple one course example.

Figure 1.5

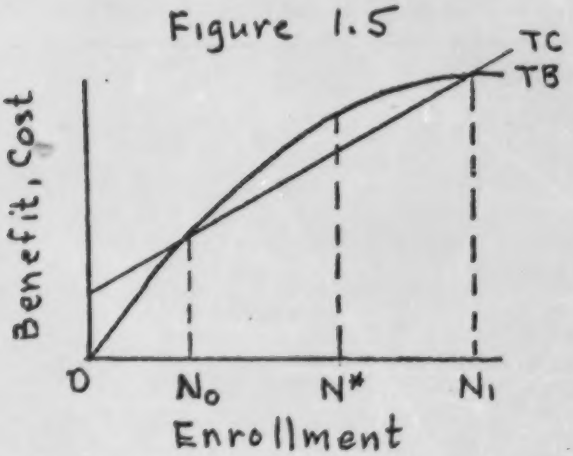
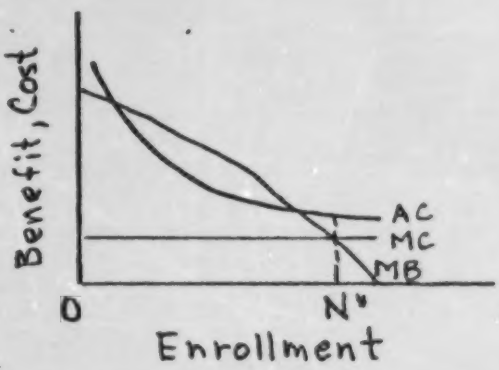


Figure 1.6



For this case it makes economic sense to establish the OLS because there exists a range of enrollment levels, from N_0 to N_1, where the net social product is positive. Furthermore, the enrollment level N* results in the maximum possible net social benefit. It is instructive to observe that at the optimal enrollment, i.e., where the vertical distance between TB and TC in FIgure 1.5 is maximum, the MB and MC curves in Figure 1.6 intersect. This makes good economic sense because for any enrollment less than N^*, where MB is greater than MC, an increase in enrollment will increase TB more than TC. Similarly, for any enrollment greater than N^*, a decrease in enrollment would subtract more from TC than from TB. Because of the equivalence of maximizing the difference between total benefit and total cost and equating marginal benefit and marginal cost, it is possible to

determine the optimal enrollment from information on either total or marginal benefits and costs. It should also be noted for future reference that while the AC curve may lie below the MB curve for some enrollment levels, it will lie above the MB curve at the optimal enrollment.

1.2. Defining and Measuring Social Benefit

In order to apply the basic framework outlined above it is necessary to be able to measure in dollar terms the social benefit associated with different levels of enrollment. Under some circumstances such measurement may in fact be made. The main issue here is whether higher education is like most other goods in the sense that (1) total social benefit is equal to the sum of the private benefits that accrue to the individual students enrolled in higher education and (2) individual students know as well as anyone else what are the benefits of higher education and are capable of making rational decisions about whether to enroll. If higher education, like many goods, does not have any significant external benefits[3] and individual students (or their parents) can best decide for themselves how much and what kind of higher education to consume, then, as will be shown below, it is possible to estimate the benefits to society of a course of given quality, subject, etc., from information about the relationship between the amount of enrollment and the price (tuition and fees) charged for enrolling.

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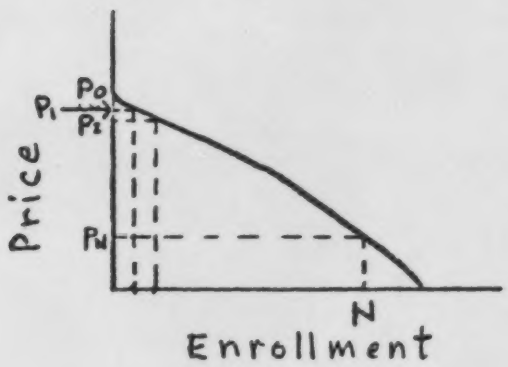
3. A good has an external benefit when persons other than the individual consumer purchasing the good are benefited by his consumption of it. For example, if your having a college degree makes you a better neighbor, then your neighbor receives benefits from your higher education without having had to pay for it. In this case there would be an external benefit from higher education. The total benefit to society would equal your private benefit plus your neighbors' benefit.

If an individual chooses to enroll in a course for which he has to pay a given fee and if he is behaving rationally, the presumption must be that the expected value of the benefits to him is at least as great as the course fee. Consequently, if there are no external benefits, the total and marginal social benefit for different enrollments can be calculated from the course demand curve, which indicates the number of students that would enroll for each possible course fee or price. An example of such a relationship is shown in Figure 1.7. Its negative slope indicates that the lower the price, the more students will choose to

Figure 1.7



enroll. For any course fee greater than P_0, no students will enroll which indicates that no one values the benefits from taking the course to be greater than P_0. At price P_1, one person would enroll which indicates he values the benefit of the course to be greater than P_1 but less than P_0. At P_2, two persons would enroll, with the second person valuing the benefits of the course between P_1 and P_2. Similarly, at P_N, N persons would enroll with the Nth person valuing the benefits to be

approximately P_N. Consequently, the sum of the maximum prices the N persons would be prepared to pay to enroll in the course would be the total benefit derived from the course with this enrollment. This sum is simply given by the area under the demand curve between 0 and N. Furthermore, the price that the Nth person would be willing to pay indicates the marginal benefit for enrollment of N. This price is simply the height of the demand curve at enrollment N.

It is possible, then, by estimating the demand curve for a given course, to approximate the total and marginal social benefits of the course for different possible enrollments under the assumptions that there are no external benefits from the course and that students make rational decisions about enrollment. If these assumptions are valid, the simple framework presented in the preceeding section can be readily used to make decisions about an OLS. Even if these assumptions do not hold, this framework can be applied if a value can be assigned to the external benefit associated with an individual's enrolling in a college level course or if some judgment can be made on the extent to which students undervalue the benefit to them of higher education. There is no escaping the fact, however, that it is necessary to quantify the amount of external benefit or miscalculation by students of private benefit if decisions about the OLS are to be made on a rational basis. If quantification can take the form of a statement as to how much the enrollment of an individual in a college level course is worth to society over and above its worth to the individual and the amount by which an individual student underestimates the private return from taking such a course, then an

appropriate government policy would be to provide a subsidy per student enrolled to the OLS equal to the sum of these two amounts. Then the OLS, in its cost benefit analysis, could replace the private demand curve with a social demand curve which is a vertical displacement of the private demand curve by the amount of the per student subsidy. The social demand curve would reflect the private benefits as perceived by individual students and any social benefits not taken into account by individual students.

1.3. Defining and Measuring Social Cost

Rational decision-making is as dependent on the availability of accurate cost estimates as it is on the availability of accurate benefit estimates. However large may be the benefits of any alternative, it is impossible to judge its desirability--i.e., its net social product--without knowing how much it will cost. In order to compare the net social products of alternatives, no matter how much they may vary in terms of social benefit, it is necessary to know how these alternatives differ with respect to cost. Furthermore, for different decisions it is essential to distinguish between different cost concepts and also different cost components.

One conceptual issue that arises in the context of cost accounting of a public institution relates to the distinction between private and social cost. In calculating the profit of a private firm, the only relevant costs are private costs, namely, those which are borne by the firm itself. For some firms, there may well be substantial costs imposed on society which are not paid for by the firm. The smoke emitted

by an electric power plant is a familiar example. And, as the prevalence of air pollution as a national problem makes clear, the difference between social cost and private cost may be very significant. In the context of an institution of higher learning, there are not likely to be significant external costs such as air pollution. Nevertheless, there may be substantial costs to society for which the institution may not have to make payment. For example, an OLS may not be required to pay for space provided to it by another academic institution. Or, it may not have to pay for the costs of television transmission on the public network. But in assessing the cost of the OLS for the purposes of deciding whether it should be established or how it should be operated, these costs are relevant to the decision.

The problem of measuring the cost to society of the OLS using facilities for which it is not charged an appropriate use fee or rental raises another conceptual distinction, the difference between opportunity cost and cash outlays. When an input into the production process has alternative uses the cash outlay required to obtain that input may not be the best measure of cost to use. Rather the value of the alternative opportunity forgone--i.e., the opportunity cost--would be the correct measure to use. Consider again the cost to society of using the public television network to transmit OLS courses to students. If there are no television programs which the network would otherwise transmit, then the cost to society of transmitting the OLS course would simply be the extra labor, materials, electric power, etc., incurred in the transmission. If offering the OLS course required the network to drop a

popular program from its schedule, then the cost to society would be the opportunity cost of having to do without the regular program, which might exceed substantially the cash costs of actually transmitting the OLS course.

One application of the concept of opportunity cost that is used in economic analyses of higher education involves the cost of student time used in attending class and studying. In the context of a full-time residential college, a student is usually required to forego the earnings he could obtain from full-time employment. From the student's point of view this is a real cost of his education even though it does not involve a cash outlay on his part to acquire the education. In assessing the desirability of attending college the opportunity cost of foregone earnings is an important factor for the student to take into account. Even for students who attend college on a part-time basis at a time which does not interfere with his regular working hours, there is the opportunity cost of leisure foregone. In fact, if the student were to allocate his time between work and leisure optimally, the costs to him of an hour of leisure foregone would be as much as the cost to him of the foregone income from an hour's work. Fortunately, this consideration is one that need not concern the educational planner unless he is considering requiring enrollment by law. As long as the enrollment decision is left for the student to make, it would be prudent to trust his judgment as to whether the benefits of enrolling in an OLS course were sufficiently great to cover his opportunity costs. Furthermore, any advantage that an OLS might have in reducing the opportunity cost to students through greater flexibility in timing and location would be

reflected in student demand for enrollment. Consequently, in estimating the cost structure it is sufficient to concentrate exclusively on instructional costs and ignore the opportunity costs of students' time.

In order to ensure that the search for optimal values of the decision variables fully takes in account the structure of instructional costs, it is essential to distinguish between fixed and variable costs. As was discussed in Section 1.1, fixed costs are those costs incurred in maintaining and operating an organization which do not change as the scale of operation changes. As a consequence, while fixed costs are important when deciding about whether to establish an OLS, they are ordinarily irrelevent to decisions about the numbers of courses to offer and students to admit. Given that the OLS is in existence, it is variable costs which are of overriding importance.

The significance of the distinction between fixed and variable costs becomes clear by considering the related distinction between average cost and marginal cost. Average cost is equal to total cost divided by the quantity of output, while marginal cost equals the increase in total cost associated with producing an extra unit of output. In general, these two costs will not be equal. For some decisions, it is clearly marginal cost that is the appropriate concept to use, but frequently it is average cost which is incorrectly used in practice. For example, in deciding whether to admit an additional student to a course, the appropriate question is whether net social product will be higher as a result. If marginal social benefit exceeds marginal social cost, then the answer is clearly yes. The correct answer would still be yes, even though the

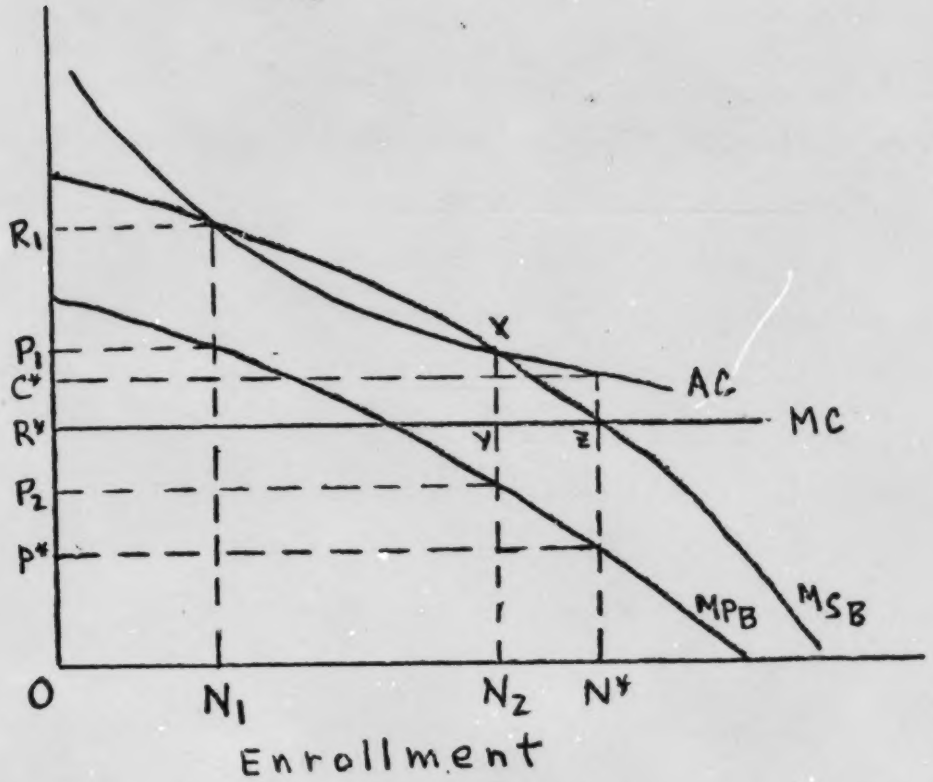
marginal social benefit as indicated by the price the student would be willing to pay plus any per student subsidy might be less than the average social cost.

1.4. Financing the OLS

The cost-benefit framework developed above has direct implications for the financing of the OLS. Assume once again that the OLS offers only one course of a given quality, subject, etc. Assume also that both the demand curve and the cost structure are known to the decision maker. The issue then becomes how, in the interests of economic efficiency, the OLS's revenues should be divided among receipts from (a) tuition and fees paid by students, (b) per student subsidies paid by the government and (c) grants paid by the government or private foundations to cover any deficit arising from the choice of optimal values for (a) and (b).

In Figure 1.8 the private and social demand curves faced by the OLS have been drawn together with the average and marginal cost curves. The curve MPB is the private demand curve which reflects the benefits of the OLS course as perceived by its potential students. The MSB curve reflects in addition to the private benefits those external benefits which potential students fail to take into account in deciding whether to enroll. The vertical distance between MPB and MSB is equal to the per student subsidy which the government would pay to the OLS to encourage it to take into account these external benefits in its decision-making. The MC curve shows the cost involved in having an additional student enrolled, while the AC curve indicates the average cost per student enrolled.

Figure 1.8



The optimal enrollment, which occurs where MC = MSB, is N* students. At this level either an increase or a decrease in enrollment would reduce net social product. Efficiency, however, also requires that the particular N* persons who do enroll must be those N* persons who value taking the course most highly. That is, each person enrolled should be prepared to pay at least as much as any person who is not enrolled. One way to ensure the optimal level and composition of enrollment is to charge

a price equal to P*. At price P*, N* students will enroll all of whom value taking the course to be at least as great as the course price, while those who choose not to enroll value taking the course to be less than P*. Consequently, by charging a price equal to marginal cost less any per student subsiy, the N* persons who value the course most highly will enroll.

Marginal cost pricing, however, will generate revenues (inclusive of per student subsidies) which will necessarily be less than the total social cost of the course as is made evident by the fact that the AC curve is always higher than the MC curve. For enrollment N*, the total social cost will be equal to the average social cost times the number enrolled or C* x N*, whereas course revenues will be only R* x N*. In order to cover its costs at the optimal enrollemtn, the OLS must receive a grant equal to its total social cost less its revenue from course fees and per student subsidies, or C* x N* - R* x N*. To carry out the optimal pricing and grant policy, the cost structure for the OLS must be identified in some detail. First, it would be necessary to measure accurately the marginal social cost in order to get the optimal course fee. Second, it would be necessary to measure the average (or total) cost for the course at the optimal enrollment in order to determine the required subsidy.

It is interesting to note what options are open to the OLS in the event that no grant is forthcoming. As the benefit and cost curves have been drawn in Figure 1.8 it is possible for the OLS to be self-supporting. At enrollments N_1 and N_2 the OLS would just break even and at intermediate

enrollment levels it would actually generate a surplus if it was prepared to charge a fee just low enough to generate such enrollments. For example, if it charged a course fee of P_1 it would generate an enrollment of N_1 and a revenue of $R_1 \times N_1$, i.e., student tuition plus subsidy, which would exactly equal total social cost. Of course, none of these possible revenue and enrollment combinations is optimal. For example, the combination P_2 and N_2, which is the self-supporting combination which is closest to the optimal solution, results in a loss in net social product relative to the maximum equal to the area XYZ. Operating at this level is better than not operating at all and would be the best choice in the absence of any subsidy, but it is clearly inferior from the point of view of society to operating at the combination P* and N* made possible by annual grants to the OLS in the amount of $C^* \times N^* - R^* \times N^*$.

1.5. Other Decision Variables

Thus far the analysis has been restricted to the case where the OLS offers only one course produced with a given educational technology, a given academic standard, etc. Clearly, the OLS must also decide how many courses to produce and what the characteristics of these courses should be. In making these decisions it is essential to take the effects on both benefits and costs into account. In comparing any two alternatives for any decision variable one would be prefereable to the other if it yielded more extra benefits than it added extra costs. From an economic point of view, the higher technical, aesthetic and academic standards are not always optimal, becuase the greater benefits may fall short of the extra costs.

Consider the case of production quality. As the quality of the presentation of the course increases, the cost of production will increase. Higher quality can also be expected to mean higher benefits; whether because a higher quality production is more effective at teaching the material, or because it is more satisfying, individual students are likely to find the experience more valuable and, consequently, to be willing to pay a higher course fee. The issue, then is simply whether any contemplated increase in production quality yields more extra benefits than extra costs. It clearly is inappropriate to presume either that the highest quality production or that the least cost production is optimal. In some situations either of these extremes might prove to be optimal, but not as a general rule.

The same considerations must be brought to bear on the questions of subject matter and academic standards. While the study of classical languages is intellectually as respectable and may have equally salutary effects on the mind as the study of any other subject, it does not follow that the benefits from offering courses in Greek and Latin outweigh the costs. If they do not, then it will not be in society's interests for the OLS to offer such courses for the resources used up could be put to more beneficial uses. Similarly, while adopting the highest academic standards may bring prestige to a university's faculty, it may not yield the greatest benefits to society. The appropriate difficulty of a course for the brightest ten percent may be inappropriate for the average student. This is true whether one considers the purpose of the course to be the increase in student understanding or the certification of passing students

as having an aptitude of some level. What the optimal level of course difficulty is will depend primarily on the characteristics of the population from which students will enroll, since the benefits are likely to vary more sharply with the degree of difficulty than are costs.

1.6. Information Requirements for Rational Decision Making

The essence of the economic approach to rational decision-making is the comparison of the social benefits and social costs for alternative values of the decision variables. The optimal values occur where the difference between total social benefit and total social cost is maximum or, in other words, where the marginal social benefit and marginal social cost are equal. Thus, in order to make optimal decisions, it is necessary to know how benefits and costs vary as the decision variables change.

The difficulty with this approach to decision-making for the UMA-SUN system is that in many cases the required knowledge of how changes in the decision variables affect benefit and cost is simply not available. Consequently, it is difficult to prove whether any particular decision is optimal. What this suggests, of course, is that one of the major objectives which the UMA-SUN OLS should be setting for itself in planning the next five years of its operations is the acquisition of the information required for rational decision-making.

What are the most important information requirements which are currently lacking? In most cases, more is known about how costs respond to changes in decision variables than how benefits respond. For example, reasonable estimates of the cost structure can be made for a given course

on a particular subject, at a certain academic level, using alternative technologies. (Such estimates are used in the following sections. While they will need to be revised with experience, enough is known about the technology to make reasonably accurate forecasts of the costs involved.) What no one knows, however, is how sensitive enrollments are to which technology is chosen. Similar examples can be given for other decision variables. While market research is a potential source of information about the effects of decision variables on benefits, UMA-SUN will have to depend on experience to acquire this information. This means that initially UMA-SUN will want to try combinations of values for its decision variables which are highly uncertain as to their eventual impact, but which will yield information which would be useful in future decision-making. For example, it would be appropriate, in order to assess the impact of television, to produce courses which utilize television in different degrees or even produce alternative versions of the same subject and offer them simultaneously to different regions. In summary, one of the great hopes for UMA-SUN is that over the next five years it can acquire an informational base which will enable it and other systems to approach the production and delivery of open learning in an informed and rational way.

1.7. Organization of the UMA-SUN System

The organizational structure of the UMA-SUN system reflects the dichotomy between the production and the delivery of open learning courses. UMA is responsible for decisions relating to the acquisition and development of courses which it can distribute to affiliated delivery systems such as SUN and unaffiliated delivery systems such as Chicago's TV

College. It must decide about the academic content, the pedagogical technique, the technology of each course, etc. SUN, along with other delivery systems in the consortium, is responsible for offering courses, enrolling and examining students, and granting course credit. It must decide which UMA courses to offer, what fees to charge, what academic services to provide enrolled students, etc.

Although decisions about production and delivery will be made by different organizations, the interdependence of the actions taken by the two organizations requires a high degree of coordination. In particular, decisions by UMA about what courses to produce must take into account student demand for prospective courses in the various affiliated delivery systems. But UMA decisions must also reflect the interest on the part of unaffiliated delivery systems in adopting and delivering its courses. One of the key issues concerning the relationship between UMA and both affiliated and unaffiliated delivery systems is what lease fees to charge for the right to use UMA courses. The socially optimal fee over and above the cost of providing a delivery system with a master copy of the course is zero. This fee would be feasible only to the extent that the costs of production of UMA courses were covered by grants to UMA from the government and private foundations. To the extent that grants are insufficient to cover the costs of UMA operations, it will be necessary to adopt the second best strategy of charging positive fees for the use of UMA courses. By charging the affiliated delivery systems a fee independent of the number of courses they adopt, UMA will be able to obtain revenue without discouraging the adoption of its courses.

2. THE COST STRUCTURE OF THE UMA-SUN SYSTEM

2.1. Cost Analysis

As was discussed in Section 1.3. above there are numerous cost concepts which must be intelligently applied in appropriate contexts in order to make rational decisions. For the purposes of this analysis, estimates will be made of the annual costs of the UMA-SUN system under alternative assumptions about the scale and nature of the system's activities. This requires cost functions which indicate the relationship between the total annual cost and the variables for which alternative assumptions will be made. Once these relationships are specified,it is a simple matter to calculate total costs for any set of assumptions about the variables involved. The cost functions also permit the straightforward calculation of average and marginal costs which are essential for undertaking cost comparisons with other academic institutions and for internal decision making.

While the cost estimates that are developed and presented in the following sections are consistent with the actual expenditure projections for UMA-SUN over the next five years, they differ from those projections in several important respects. First, any expenditure for an asset with a useful life exceeding one year will be amortized over the life of the asset and only the annual amortized cost will be included in the cost estimates. Second, certain items will be included in the cost estimates for which no expenditure will ever be made and certain expenditures will not be reflected in the cost estimates. Typically, this will occur in situations where UMA-SUN incur costs which are paid for by someone else or where UMA-SUN must make expenditure for items which do not involve

any social cost. Third, the cost analysis will presume that UMA-SUN has reached a steady state equilibrium, while the expenditure projections for 1975-1979 will include certain start-up costs which cannot be expected to prevail in steady state. Finally, the cost analysis abstracts from price level changes over time; all cost calculations are in 1974 prices.

2.2. The UMA Course Production System

The main function of the UMA course production system is to acquire existing and to develop new courses suitable for open learning and to distribute these courses to both affiliated and unaffiliated delivery systems. Two factors make up the main determinants of total cost for the UMA course production system: (1) overhead administration and (2) the number and types of courses produced.

2.2.1. Overhead Administration. This category includes all activities which are necessary to maintain and operate the UMA system independent of the scale of its operations. Whether UMA has ten, forty or a hundred courses available for distribution, the costs of these activities would be the same. Present estimates for the cost of overhead administration by function and by type of expense are as follows.

General Administration

Employees	$163,345	
Operating Expenses	89,693	
Supplies & Material	1,100	
Travel	20,750	
Total		$274,888

Academic Administration		
Employees	$82,656	
Operating Expenses	24,934	
Supplies & Materials	400	
Travel	4,920	
Total		$112,910
Public Affairs and Information Services		
Employees	14,515	
Operating Expenses	5,337	
Supplies & Materials	600	
Travel	2,528	
Total		22,980
Production Services		
Employees	39,670	
Operating Expenses	5,890	
Supplies & Materials	900	
Travel	2,436	
Total		48,896
Research and Evaluation		
Employees	52,183	
Operating Expenses	8,049	
Supplies & Materials ...	1,100	
Travel	2,180	
Total		63,512
Instructional Design		
Employees	51,990	
Operating Expenses	5,749	
Supplies & Materials	200	
Travel	1,708	
Total		59,647

Delivery System Coordination		
Employees	$27,891	
Operating Expense	8,362	
Supplies & Materials ...	300	
Travel	4,515	
Total		$41,068
Total Overhead Administration		$623,901

Rounding this estimate to the nearest $5,000, yields a figure of $625,000 for the fixed costs of the UMA course production system.

2.2.2. Courses. For UMA to have an additional course available to distribute to its affiliated delivery systems it is necessary for it to incur the costs of course development, revision, and distribution. Since the typical course will last for more than one year and since some course costs are not distributed evenly over the life of the course, it is necessary, in order to calculate the annual cost of the course, to amortize the development and revision costs over the life of the course. On the assumption that each course lasts ten years and major revision takes place at the end of the fifth year, with lesser revisions after two and seven years, the annual course cost, A, can be calculated from the following equation, where P is the production or acquisition cost, R_i is the revision cost in the ith year, M is the yearly distribution cost, and r is the rate of interest:

$$(2.1) \quad A = M + \left[P + \frac{R_2}{(1+r)^2} + \frac{R_5}{(1+r)^5} + \frac{R_7}{(1+r)^7} \right] \left[\frac{r(1+r)^{10}}{(1+r)^{10}-1} \right]$$

The development of five different course types is envisioned. The estimated development, revision, distribution and annual costs for

each type is shown in Table 2.1.

Table 2.1. Production Cost by Course Type

Course type	Development cost	Minor Revision cost	Major Revision cost	Distribution cost	Annual cost
A	$ 680,000	$ 100,000	$ 340,000	$ 10,000	$ 175,000
B	425,000	75,000	212,000	10,000	115,000
C	240,000	50,000	120,000	10,000	70,000
D	50,000	0	0	15,000	25,000
E	280,000	65,000	140,000	10,000	60,000

Type A is heavy TV, Type B is moderate TV, Type C is no TV, Type D is acquired/intact, and Type E is acquired/adapted.

Development and revision costs for all course types except type D include certain expenses for administration amounting to $50,000 for course development and $20,000 for course revision. The estimates for the annual cost assume a 10 percent rate of interest. All estimates have been rounded to the nearest $5,000.

Current plans call for the production over the next five years of 42 courses which would carry degree credit. In addition, 13 non-degree courses will be developed, each of which would be the equivalent of four-ninths of a degree course in terms of both educational output and cost. The projected number of degree and non-degree courses by type are shown in Table 2.2.

Table 2.2. Number of Courses by Type

Course Type	Degree Courses	Non-degree Courses	Degree-Equivalent Courses	Percent of Degree Equivalent Courses
A	5	0	5.0	10.5
B	7	3	8.3	17.4
C	4	1	4.4	9.2
D	7	3	8.3	17.4
E	19	6	21.7	45.4
Total	42	13	47.8	100.0

If courses are developed in these proportions, then the average degree equivalent course will have an annual cost of approximately $75,000.

2.2.3. Cost Functions. The preceding assumptions and estimates imply the following total cost function for the UMA course production system:

(2.2) $TPC = 625{,}000 + 75{,}000\ C$

where TPC is the total annual production cost and C is the number of degree-equivalent courses of the average type.

Given the type and number of courses produced, the average production cost per student degree-equivalent course will depend on the number of delivery systems which adopt the average course and the average enrollment per course per year per delivery system. This relationship is shown in the average cost function as follows:

(2.3) $APC = [75{,}000 + 625{,}000/C]/[S \times D]$

where APC is the average annual production cost per student degree-equivalent course, C is the number of degree equivalent courses, S is the average enrollment per year per course per delivery system and D is the average number of delivery system (both affiliated and unaffiliated)

adoptions per course. Table 2.3 shows average cost computations for alternative values for S and D given that 48 degree-equivalent courses of the average type are produced.

Table 2.3. Average Production Cost per Student Degree-Equivalent Course

(48 degree-equivalent courses; 1974 prices)

D = Average Number of Affiliated plus Unaffiliated Delivery System Adoptions per Course

S = Average Enrollment per Course Adopted per Delivery System

D	S				
	100	200	300	500	1000
1	880	440	294	176	88
2	440	220	147	88	44
3	294	147	98	59	29
4	220	110	73	44	22
5	176	88	59	35	18
6	147	73	49	29	15
7	126	63	42	25	13
8	110	55	37	22	11

2.3. The SUN Course Delivery System

While SUN is only one of several course delivery systems to be affiliated with UMA, it can be regarded as a prototype system and can be expected to have a representative cost structure. The total costs of the delivery system will be determined by four factors: (1) overhead administration, (2) learning centers, (3) courses offered and (4) enrollment per course.

2.3.1. Overhead Administration. The delivery system has three functions: general administration, academic services and student services. Estimates of the fixed costs incurred in establishing the minimal capability to carry out these functions are listed below by function and cost category.

General Administration		
Employees	$33,725	
Operating expenses	6,117	
Supplies & Materials	200	
Travel	1,236	
Total		$41,278
Academic Services		
Employees	$27,319	
Operating expenses	3,617	
Supplies & Materials	100	
Travel	1,470	
Total		32,506
Student Services		
Employees	$27,319	
Operating expenses	3,817	
Supplies & Materials	100	
Travel	1,780	
Total		33,016
Total Cost of Overhead Administration		106,800

This fixed cost of approximately $105,000 will be incurred independent of the number of learning centers, the number of courses offered or the number of students enrolled.

2.3.2. Learning Centers. A potentially substantial cost item for SUN is the operation of up to 25 learning centers throughout Nebraska. The fixed costs of operating a learning center, independent of the number of courses offered and the number of students enrolled and using the center, is approximately $32,000. This breaks down into costs by type

as follows:

Employees	$26,880	
Operating Expense ...	4,578	
Supplies & Materials ..	100	
Travel	192	
Total Fixed Costs per Learning Center		$31,750

2.3.3. Courses. The mere fact of offering a course will involve certain expenses regardless of the number of students enrolled in the course. For a SUN course, it is assumed that for each credit-equivalent course it will be necessary to have a faculty member for the equivalent of three-sixteenths of a year and a part-time secretary, office space, supplies, etc. His or her primary responsibility would be to supervise both communications with students and learning centers and evaluation of student performance. The estimated annual cost per course independent of the number of students enrolled is approximately $6,500. This breaks down into cost by type as follows:

Employees	$4,818	
Operating Expense	595	
Supplies & Materials..	100	
Travel	1,000	
Total Fixed Costs per Course		$ 6,513

2.3.4. Students. Costs also vary with the number of students enrolled in courses. Each additional student will increase the requirements for academic advising and evaluation, registration and other student services, and course materials supplied to the student. The cost of these requirements is $55. The cost breakdown by category is given below.

Academic Advising		
Graduate assistant	$12.00	
Secretary	2.50	
Telephone	4.75	
Postage and printing	2.00	
Building and equipment	2.15	
Total		$23.40
Student Services		
Employees	3.95	
Data processing	1.00	
Postage and printing	1.00	
Building and equipment	.45	
Total		6.40
Course Materials		25.00
Total Student Cost		$54.80

2.3.5. Cost Functions. The cost estimates presented in the foregoing sections for overhead administration, learning centers, courses offered and students enrolled imply the following total and average cost functions:

$$(2.4)\quad TDC = 105{,}000 + 32{,}000L + (6{,}500 + 55S)Z$$

$$(2.5)\quad ADC = 55 + (105{,}000 + 32{,}000L)/(S \times Z) + 6{,}500/S$$

where TDC is total delivery cost for the SUN delivery system, L is the number of learning centers, Z is the number of courses offered by SUN and S is the number of students enrolled per course offered. These equations can be restated in terms of the total enrollment in SUN courses as follows:

$$(2.6)\quad TDC = 105{,}000 + 32{,}000L + 6{,}500Z + 55N$$

$$(2.7)\quad ADC = 55 + (105{,}000 + 32{,}000L + 6{,}500Z)/N$$

where $N = S \times Z$.

From equation (2.6) it can be seen that the marginal cost of an extra enrolled student, given the number of courses and learning centers is $55. Also, for an enrollment of 15,000 students, with 48 courses and 25 learning centers, the total delivery cost would be $2,032,000 and the average delivery cost per student would be $135. In Table 2.4 below, the average delivery cost per student enrolled is shown for alternative assumptions for the variables Z, L and S.

Table 2.4. Average Delivery Cost per Student Degree-Equivalent Course

(1974 prices)

Z = Number of Courses Offered by Delivery System (SUN)
L = Number of Learning Centers
S = Average Enrollment per Course Offered

Z	L	S				
		100	200	300	500	1,000
24	25	497	276	202	143	99
24	0	158	109	91	77	66
(N) Total Enrollment:		(2,400)	(4,800)	(7,200)	(12,000)	(24,000)
48	25	308	182	140	106	80
48	0	142	98	84	72	64
(N) Total Enrollment:		(4,800)	(9,600)	(14,400)	(24,000)	(48,000)

2.4. The Complete Open Learning System.

From the cost functions for the UMA course production system and the SUN prototype delivery system it is possible to compute the estimated costs for the complete OLS given assumptions about the values for the key variables which affect costs. In Table 2.5, below, the average cost per student course is shown for alternative sets of assumptions.

Table 2.5. Average Instructional Cost per Student Degree-Equivalent Courses

(48 UMA courses; 1974 prices)

D = Average Number of Affiliated plus Unaffiliated Delivery System Adoptions per UMA Course

Z = Average Number of Courses Offered per Affiliated Delivery System

L = Average Number of Learning Centers per Affiliated Delivery System

S = Average Enrollment per UMA Course Offered per Delivery System (Affiliated and Unaffiliated)

D	Z	L	S				
			100	200	300	500	1,000
1	24	25	1,377	716	496	319	187
2	24	25	937	496	349	231	143
3	24	25	791	423	300	202	128
4	24	25	717	386	275	187	121
1	24	0	1,038	549	385	253	154
2	24	0	598	329	238	165	110
3	24	0	452	256	189	136	95
4	24	0	378	219	164	121	88
2	48	25	748	402	287	194	124
4	48	25	528	292	213	150	102
6	48	25	455	255	189	135	95
8	48	25	418	237	177	128	91

Table 2.5. (continued)

D	Z	L	S				
			100	200	300	500	1,000
2	48	0	582	318	231	160	108
4	48	0	362	208	157	116	86
6	48	0	289	171	133	101	79
8	48	0	252	153	121	94	75

In order to interpret the average cost estimates presented in Figure 2.5, it is necessary to understand the relationship between the number of adoptions of UMA courses (D), the number of course offerings per affiliated delivery system (Z), and the number of affiliated delivery systems. It is important to remember that UMA courses can be adopted by unaffiliated delivery systems and that the affiliated delivery systems need not adopt all the UMA courses. Consequently, it is possible to interpret the first row of Table 2.5 as being consistent with there being two affiliated delivery systems each adopting 24 courses or there being one affiliated delivery system adopting 24 courses and one or more unaffiliated delivery systems adopting a total of 24 courses. The second row is consistent with there being one, two, three or four affiliated delivery systems adopting an average of twenty-four courses each along with an appropriate number of course adoptions by unaffiliated delivery systems ranging from 72 to 0.

In calculating the average cost per student course in the UMA-SUN system, it is necessary to know what portion of the UMA production cost should be attributed to students enrolled in UMA courses offered by unaffiliated delivery system. In Table 2.5, the UMA production cost is

divided equally among all students enrolled in UMA courses regardless of delivery system. To perform this calculation it is assumed that enrollment per course offered (S) is the same for both affiliated and unaffiliated delivery systems.

2.5. Cost Comparisons

In order to assess the relative costliness of the UMA-SUN system, the average instructional costs for two alternative systems--the British Open University and the conventional higher education in the United States--are presented below. The issue here is how does the cost of establishing and operating the UMA-SUN system compare with the cost of educating the same students in the alternative systems. For the purpose of this comparison the appropriate basis is average cost for the same number of students. It should be remembered, however, that a cost comparison by itself cannot determine whether UMA-SUN is more or less desirable from society's point of view than the alternatives. Such a judgment must also take into account a comparison of the benefits that each would provide.

2.5.1. The British Open University (BOU).[4] The following cost figures for the BOU are based on estimates of the costs of operations in steady state with 42 courses at an academic level comparable to the proposed UMA courses designed for a total enrollment in the range of 20-55 thousand students. The structure of the BOU is very similar to the UMA-SUN system, and, not surprisingly, it has a similar cost structure,

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4. This section is based on K. G. Lumsden, "The Economics of the Open University," (TEFERC, Mimeograph).

namely, fairly substantial fixed costs and fairly low marginal costs. As a consequence, the BOU, like UMA-SUN, requires a large total enrollment in order to achieve low average costs.

The fixed costs by type are shown in Table 2.6. Two items require some elaboration. The costs for regional administration cover the operation of 14 regional offices, each of which has a staff including a director, three or four senior counsellors and five to seven staff tutors. These personnel do not deal directly with students but supervise the counsellors and advisers who do. With respect to faculty and academic services and also course production, the bulk of these costs are for the development of new courses to replace courses which are becoming obsolete and the revision of existing courses which are to be retained.

Table 2.6. Fixed Costs for the British Open University

(1974 prices)

Buildings and Equipment	$ 4,077,000
Central Administration	3,733,000
Regional Administration	4,934,000
Faculty and Academic Services	5,035,000
Course Production	5,004,000
Miscellaneous	4,025,000
Total Fixed Costs	$ 26,809,000

The main determinant of variable costs, given the number of courses offered, is the total enrollment in BOU courses. The variable costs per student by category are shown in Table 2.7.

Table 2.7. Variable Costs Per Student

(1974 prices)

Correspondence	$ 96
Tutoring and Counseling	106
Summer School	81
Data Processing	12
Examinations	20
Study Centers	8
Variable Cost per Student	$ 323

One of the difficulties in comparing the BOU with UMA-SUN is that each BOU course is approximately equal to five UMA courses. An Honours BA from the BOU requires eight courses, while a BA from SUN will require 40 UMA courses. One way to adjust for the difference in courses is to divide all costs by a factor of five. It is difficult to judge the bias that this adjustment introduces, but it is most likely to understate the average cost of the BOU, because it would probably be impossible to reduce all costs proportionately in scaling down the "size" of a BOU course. The result of this adjustment is an approximate average cost function for the BOU as given in equation (2.8).

$$(2.8) \quad AC = 65 + 5{,}360{,}000/N$$

This is not very different, for example, from the cost structure for a UMA-SUN system with the following characteristics: four affiliated delivery systems, ten learning centers per delivery system, 42 UMA courses and 21 adoptions by each delivery system. The average cost function for this UMA-SUN system is shown in equation (2.9).

$$(2.9) \quad AC = 55 + 6{,}019{,}000/N$$

The implications of equations (2.8) and (2.9) for average cost under alternative assumptions about N are shown in Table 2.8.

Table 2.8. Average Cost per Student Course for BOU and UMA-SUN

(1974 prices)

Enrollment*	BOU	UMA-SUN
50,000	172	175
40,000	199	205
30,000	243	255
20,000	333	355

*Enrollment assumptions are for the entire OLS.

Alternative methods for adjusting for differences between BOU and UMA courses would raise somewhat the average cost estimates for the BOU. It is equally true that alternative organizations of the UMA-SUN system, in terms of numbers of delivery systems and learning centers per delivery system, would yield higher average costs in some cases and lower average costs in others. What equations (2.8) and (2.9) and Table 2.8 make clear, however, is that these two open learning systems have very similar cost structures.

2.5.2. Public Conventional Colleges and Universities.[5] Unfortunately, the data on costs for conventional colleges and universities makes it practically impossible to construct a cost function for conventional institutions of higher learning. Nevertheless, it is possible to obtain estimates of the average instructional cost for the system as a whole as it is currently orgainzed and also for broad categories of institional types. These estimates are shown in Table 2.9.

5. This section is based on J. O'Neill, Resources Use in Higher Education, (Carnegie Commission on Higher Education, 1971).

Table 2.9. Average Instructional Costs by Type of Institution

(1974 prices)

	All Undergraduate Courses	Lower Division Courses
Universities	$ 263.	$ 181.
4-Year Colleges	224	170.
2-Year Colleges	165	165
Liberal Arts Colleges	246.	246
All Public Institutions	229	175

In comparing these estimates with the array of average cost computations for the UMA-SUN system shown in Table 2.5, it is clear that for a wide range of plausible assumptions about the key variables influencing cost, the UMA-SUN system is very competitive, even with the least costly segments of conventional higher education.

3. THE BENEFIT STRUCTURE OF THE UMA-SUN SYSTEM

3.1. Demand for Open Learning.

Despite the fact that in the United States the opportunities for conventional higher education are greater per capita than in any other country in the world today, significant numbers of citizens do not take advantage of these opportunities. The principal reasons are that many of these individuals do not have the academic credentials to gain admission or are unwilling to bear the loss of income from full-time employment that would result from pursuing a traditional college education. Continuing education classes, sponsored primarily by existing institutions of higher learning, have been able to satisfy part of the demand of such people, but the evidence suggests that substantial unfilled demands remain. The UMA-SUN system is being designed to help meet such demands.

For such a system to be worth establishing the anticipated social benefits must at least equal the expected social costs. As was seen in Section 2, under a variety of assumptions the fixed costs of any relatively sophisticated open learning system are likely to be substantial. Consequently, economic viability, under plausible assumptions about benefits accruing to individuals enrolling in the system, given existing cost estimates, undoubtedly will necessitate a large enrollment of students.

Adoptions of UMA courses will fall into two categories: adoptions by affiliated delivery systems, i.e., the members of the UMA consortium such as SUN, and adoptions by unaffiliated institutions, e.g., colleges and universities which find UMA courses substitutes for, or complements

to, their traditional offerings. As with any new product, the extent of these demands is unknown, but they will ultimately depend on the demand for enrollment in UMA type courses offered by delivery systems. Unfortunately, it is virtually impossible to quantify the demand for enrollment in UMA courses since the necessary data are non-existent. Nevertheless, it is important to consider what factors are likely to affect demand since it is a primary objective of UMA-SUN to identify the effects of these factors on demand through experimentation and evaluation during its first five years of operation.

In specifying a demand function the dependent variable is quantity demanded in some given time period and the independent variables constitute all of the factors which influence the dependent variable. As a practical matter, however, those factors which are likely to be insignificant or incapable of being identified or measured will be ignored. Four questions arise: First, what are the factors which significantly affect the demand for UMA courses? Second, what is the form of the demand function and what are the parameters which indicate how changes in the determining factors effect demand? Third, is the function stable or does it change over time? Finally, which of the significant factors are decision variables of UMA-SUN? It is important to reiterate that while the above questions cannot be answered at this time, the answers will have to be sought as UMA evolves in order to make rational decision-making feasible and, thereby, come as close as possible to establishing an optimal open learning system.

In traditional economic models of demand the factor which receives the greatest attention is the price of the commodity to be sold, in this case tuition for enrollment. In considering the demand for enrollment in UMA courses, price undoubtedly will be important, but other factors cannot be neglected. In considering the demand for open learning enrollment, it is useful to consider the factors in two categories: the characteristics of the student population and the characteristics of the open learning system. In general, the first category will be outside of the control of the decision-maker and the second category will be composed of decision variables. Table 3.1 lists

Table 3.1. Factors Which Determine Demand for Open Learning

Student Population Characteristics	Open Learning System Characteristics
a. Size of population	h. Number of courses offered
b. Age distribution	i. Number of learning centers
c. Income	j. Frequency of course offerings
d. Location	k. Subject matter of courses
e. Amount of "leisure" time	l. Principal media used in courses
f. Alternative educational opportunities	m. Quality of courses
g. Previous education	n. Tuition

In order to measure the impact of changes in each of these factors on the dependent variable, a demand function with a specific functional form would have to be estimated with actual data. This process would be aided significantly by choosing whenever possible values for decision variables which increase the amount of information about the effects of these variables on demand.

From the demand function it is possible to construct the demand curve which shows diagrammatically the relationship between the price of enrollment and the quantity of enrollment given the values for all other variables which influence the demand for enrollment. Any change in the value of these other variables will cause a shift in the demand curve. Since the demand curve reflects what students are willing to pay to gain enrollment in a UMA course, it indicates the marginal private benefit and can be used to obtain a measure of total private benefit for different levels of enrollment. (See Section 1.2 for a discussion of this point.)

Prior to making its decisions, UMA-SUN will have to assess what benefits if any accrue from enrollment over and above those reflected in the demand curve. This is an even more difficult task than estimating the private benefits. However, to the extent that appropriate government authorities are prepared to provide a per student subsidy, it would be reasonable for the open learning delivery system to treat the amount of the subsidy as a measure of the external benefit per student enrolled. While the political process may produce what appears to many to be arbitrary decisions and in this instance, an arbitrary evaluation of social benefits, the nature of these benefits is such that any ultimate determination as to their value must be political in nature.

Given the demand curve and any per student subsidy, a marginal social benefit curve or social demand curve can be constructed as shown in Figure 3.1. The MPB curve is the private demand curve and MSB is the social demand curve. The MPB curve shows the number of students that would enroll for different tuition rates in a given time period

Figure 3.1

assuming given values for all other factors influencing demand shown in Table 3.1. Another way of stating this relationship is that the MPB shows for any enrollment the price which the last person enrolled would be willing to pay to enroll. The vertical difference between MSB and MPB is the per student subsidy which the government is willing to pay to the OLS for each student enrolled.

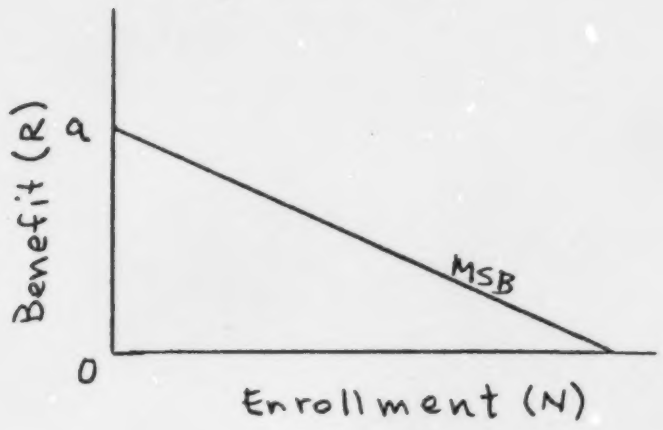
3.2. Calculation of Total Benefits

On the assumption that it will ultimately be possible to obtain accurate estimates of the demand function for open learning, it is useful to consider how such information might be used to assess the social value of the UMA-SUN system and to decide on the optimal values for decision variables. To this end, a number of plausible assumptions are made about the demand for enrollment in the SUN delivery system and their implications are worked out for the optimal enrollment in SUN and the total benefit and net social product generated by the UMA-SUN system. Throughout this analysis, SUN should be thought of as part of a consortium of delivery systems, each member of which should be considered to be

identical to SUN for this exercise.

For the sake of simplicity, suppose that the social demand curve is linear as shown in Figure 3.2. The negative slope indicates that as

Figure 3.2



enrollment increases, the marginal social benefit--the price the additional student would be willing to pay plus the external benefit resulting from his enrollment--decreases. The social demand curve can be represented algebraically as follows:

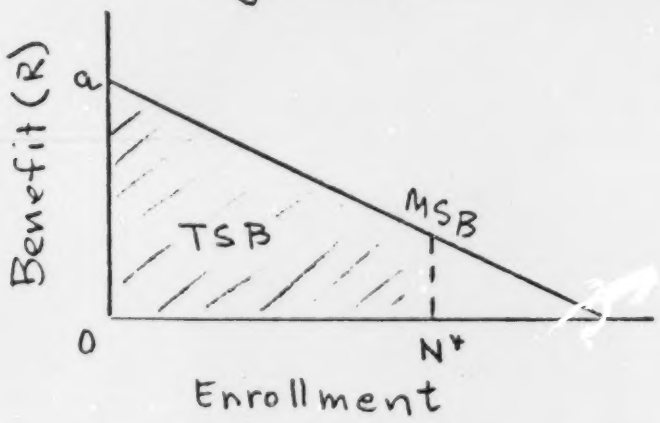
(3.1) $R = a + (b/K)N$

where R is the price for enrollment plus any per student subsidy, N is total enrollment in SUN, K is the maximum enrollment in SUN as determined by demographic factors, and a and b are the at present unknown parameters. The parameter a corresponds to the intercept on the vertical axis and the parameter b divided by K corresponds to the slope of MSB in Figure 3.2. If the intercept on the horizontal axis, i.e., the enrollment when price plus subsidy is zero, equals K, then $b = -a$.

The social demand curve for open learning is defined to be a reflection of both the private benefits which accrue to the individual

students who enroll and the external benefits which accrue to the rest of society. Consequently, it can be used as a basis for measuring the total social benefit generated by the OLS. Since the demand curve in Figure 3.3 shows the marginal social benefit for any given enrollment, for example the optimal enrollment N*, the total social benefit is equal to the area under the curve up to N*

Figure 3.3



Mathematically, the expression for total social benefit is derived in equation (3.2).

$$(3.2) \qquad TSB = \int_0^{N^*} (a + (b/K)\,N)dN = aN^* + (b/2K)N^{*2}$$

The expression for the average social benefit for enrollment N* is simply

$$(3.3) \qquad ASB = a + (b/2K)N^*$$

In order to calculate either the total or the average social benefit for comparison with total or average social cost it is first necessary to choose N*. The optimal enrollment can be found by equating marginal social benefit and cost. The estimate from Section 2 for the

marginal social cost is $55. By setting marginal social benefit to equal $55 it is possible to find N* as follows:

$$(3.4)\quad \begin{cases} MSB = a + (b/K)N = 55 \\ N^* = (55 - a)(K/b) \end{cases}$$

Given N* and estimates for a, b and K the average social benefit can be calculated and directly compared with the average cost estimates for corresponding enrollments from Section 2.

The logic of this approach can be readily seen by taking a concrete example. Suppos we assume that the value of a is 250, the value of b is -250 and the value of K is 18,500 (or two percent of Nebraska's adult population as suggested by SUN's market survey). This means that the maximum value to anyone's enrolling in a UMA-SUN course is $250 and that the value of enrolling an additional student when 18,500 students are enrolled is $0. Given these arbitrary assumptions, the optimal enrollment as calculated from equation (3.4) is approximately 14,400 students. And, from equation (3.3) the average social benefit is $153. Accepting this estimate as realistic, for the moment, the question then becomes how this compares with the average instructional cost for the UMA system with an enrollment 14,400 in each delivery system. From the cost function (2.7) in Section 2, it is clear that the average cost with a given enrollment depends on how the OLS is organized. Table 3.2 shows the average cost under alternative assumptions about the numbers of course offerings and learning centers per delivery system from equation (2.7).

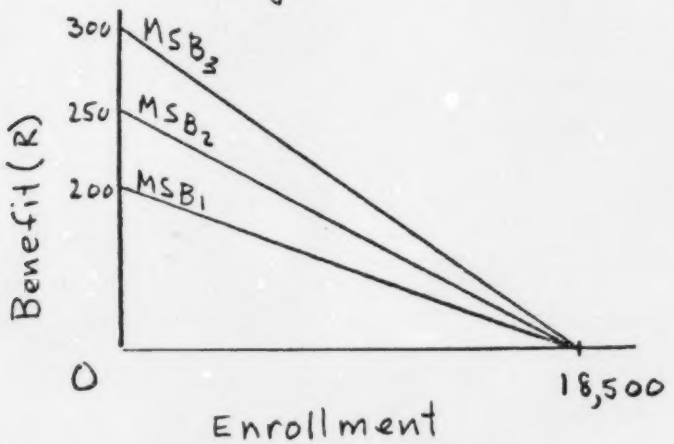
Table 3.2. Average Cost per Student Course
(1974 prices)

Enrollment per delivery system = 14,400

Adoptions per UMA Course	Number of Course Offerings	Number of Learning Centers	Average Cost
8	48	25	177
4	24	25	166
8	48	10	144
4	24	10	132
8	48	0	121
4	24	0	110

If it could be assumed that the demand for enrollment were independent of the OLS's characteristics then maximizing net social product would simply be a matter of minimizing average cost. However, as discussed in Section 2.1, the demand for enrollment is likely to depend on certain decision variables. In terms of the hypothetical linear demand curve specified in equation (3.1) and Figure 3.2, the value of the parameters a and b would depend on characteristics of the OLS such as the number of learning centers in operation and the number of courses offered. For example, three social demand curves are shown

Figure 3.4



in Figure 3.4. Curve MSB_1 is the demand curve if the delivery system offers 48 courses and has 0 learning centers, MSB_2 shows demand curve for 48 courses and 10 learning centers and MSB_3 corresponds to 48 courses and 25 learning centers. To make the example more concrete, assumptions about the parameter values for each case have been made and the implicatons for optimal enrollment and average social benefit are shown together with the corresponding cost estimates and resulting net social product estimates in Table 3.3.

Table 3.3. Hypothetical Benefit and Cost Comparison

	Case 1	Case 2	Case 3
Courses offered	48	48	48
Learning centers	0	10	25
Parameter a	200	250	300
Parameter b	-200	-250	-300
Optimal enrollment	13,400	14,400	15,100
Average Social Benefit	128	153	178
Average Social Cost[1]	126	143	171
Total Social Benefit[2]	1,715,200	2,203,200	2,687,800
Total Social Cost[2]	1,688,400	2,059,200	2,582,100
Net Social Product[2]	26,800	144,000	105,700

1. Assuming 8 adoptions per UMA course
2. Per delivery system

In this hypothetical example, both total benefits and total cost increase with the number of learning centers, although not at the same rate. In all three cases, total benefits exceed total cost. In comparing

case 2 and case 1, the increase in benefits from increasing the number of learning centers from 0 to 10 exceeds the increase in costs. In comparing case 2 and case 3, the increase in benefits from increasing the number of learning centers from 10 to 25 falls short of the increase in costs. Consequently, of the three alternatives, case 2 has the largest net social product, as can be seen in the last line of Table 3.3.

3.3. The Need for Research and Experimentation

While there exists some evidence which suggests that the demand for high quality open learning may be substantial, the unfortunate fact is that the information required to estimate with any confidence the demand function for enrollment in SUN and other open learning delivery systems is not available. The experience with other non-conventional educational institutions in the United States is so recent and poorly documented that it provides no practical guidance. The data for the British Open University, because of the substantial differences between the higher education industries in the U.S. and U.K., are not applicable to the SUN situation. And, the data from the market research undertaken for SUN leaves too many questions unanswered to provide a sound basis for making demand projections.

One of the exciting aspects of the establishment of an operational open learning system like UMA-SUN is that it provides the opportunity to acquire information about the nature and extent of demand for open learning courses--information which would be of great value not only to UMA-SUN decision makers, but to educational planners throughout the United States. This is one reason why planning for UMA-SUN over the next five years must include consideration of the quantity and types

of information which its activities will generate. In short, UMA-SUN must develop, as it appears to have begun doing, a rational experiment design.

Since an experiment is undertaken to generate data on the effects of different factors on certain variables, an optimal design must provide for sufficient variation in each of the factors to be investigated. Furthermore, the variation in the several factors must be such that it will be possible to identify the individual effect of each factor and any joint effects of variables that might occur. For example, suppose it is decided to estimate the effects of TV and production quality on demand for enrollment. Then it would be necessary to offer courses that varied in terms of both TV and quality. Suppose further that the relevant alternatives were high TV and low TV and high quality and low quality. In order to find out what the effects of these variables were, then courses would have to be offered with the following characteristics:

1. High TV and high quality
2. Low TV and high quality
3. High TV and low quality
4. Low TV and low quality

If only types 1 and 3 were offered it would be impossible to identify the different effects on demand of high and low TV. If only types 1 and 2 were offered, it would be impossible to determine whether quality of production made any difference. And, if only types 1 and 4 were offered it would be impossible to distinguish between the effects of differences in TV and differences in quality on demand.

In planning what courses to offer in what circumstances, a decision must be made as to what effects on demand are most important to identify. Obviously the factors which are expected a priori to have a substantial influence on demand must be considered. But, so too must the factors which are expected to effect cost substantially, among the latter group, some of which are also in the former group, are the course production type (A, B or C), the number of learning centers and the number and frequency of course offerings. It is clear from the UMA-SUN preliminary report that considerable variation with respect to these variables has been built into the UMA course production plans and that the opportunity for considerable experimentation by the SUN delivery system with respect ot learning centers and course offerings is present. In order to ensure, however, that meaningful inferences can be drawn from the evidence generated by five years of operation, detailed research and evaluation plans must be constructed along with the development and operations plans.

4. CASH FLOW IMPLICATIONS OF THE UMA-SUN MODEL

In Sections 2 and 3, the costs and benefits of operating the UMA-SUN system were presented and compared for alternative assumptions about key variables and parameters. The purpose was to consider whether the net social product of UMA-SUN would be positive and to determine how net social product would vary as decision variables changed in value. In this section projections of receipts and expenditures are made for a ten year period for a wide range of assumptions. The purpose here is to estimate the amount and timing of cash grants to UMA and to SUN that would be required to make operation for the given assumptions feasible.

The projections are organized into three groups. The first group consists of projections for UMA for different assumptions about the number of affiliated delivery systems, the number of adoptions by unaffiliated systems per course and the lease fee per course. The second and third groups consist of projections for SUN. The two groups differ with respect to the book fee and state subsidy per student and within each group projections differ with respect to the number of learning centers, the number of courses offered and the enrollment per course offered. The first page of each group states the assumptions which underly each projection within the group.

Appendix C

A Review of the Context of Cost Analysis

by

Philip Doughty

(Draft)

January 1974

A REVIEW OF THE CONTEXT OF COST ANALYSIS

by

Philip Doughty

From: COST ANALYSIS AND TEACHER EDUCATION:
A Comment on Relevant Relationships
A Review of Existing Models

by

Philip Doughty and Albert Beilby
Syracuse University

Sponsored by
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Division of Teacher Education and Certification

(Draft)
January 1, 1974

ABSTRACT: A Review of the Context of Cost Analysis

by

Philip Doughty and Albert Beilby

This paper provides both a conceptual framework and a review of the literature for examining issues related to cost-effectiveness analysis in higher education. The authors draw upon the disciplines of economics, operations research, and instructional development to construct their views. Cost-effectiveness analysis is discussed as a type of systems analysis, to be differentiated from cost-benefit analysis, unit cost analysis, cardinal weighting analysis, ordinal ranking, and best guess decision making. What each of the types of systems analysis have in common is a systematic comparison of alternatives, in quantitative and/or qualitative terms, using logical sequences that can be retraced and verified. What differentiates cost-effectiveness analysis from the other types of systems analysis is the method used in the comparison of alternatives.

Cost-effectiveness studies may be designed to serve top level decision makers, or the several levels of program staff. The level of cost-effectiveness analysis should be geared to the users of the data. Furthermore, users of cost-effectiveness data may be interested in the functions of control, planning, evaluation, and/or development. The level of analysis, as well as the function(s) to be served, should indicate whether the general purpose of the study is description, prediction, or comparison. The authors describe each of the three general purposes of cost-effectiveness studies, as well as the two approaches (fixed effectiveness; fixed cost) to the comparison of alternatives. Preliminary feasibility analysis can lead to a tentative determination of the level, function, purpose, and approach for cost-effectiveness studies. The identification of constraints and capabilities serve as the focus for feasibility analysis, and should be reported in the documentation of cost-effectiveness studies.

The authors describe in detail "models" for assessing cost and effectiveness. Program budgeting is contrasted with traditional budgeting; cost considerations such as inheritance, research and development, and time are discussed; cost categories are defined; and, cost estimating relationships are introduced. Recent studies using cost analysis models in higher education are reviewed under the headings of jurisdictional costs, functional costs, problems with cost, predictive costs, and comprehensive approaches. A resource allocation model as well as Rand Corporation's MODIA (A Method of Designing Instructional Alternatives) are also identified. Effectiveness models are discussed with reference to the problems of evaluative criteria and prediction.

The authors conclude that there is no lack of theoretical models for systems analysis, and that large comprehensive management information systems are in various stages of development and will provide information for high level decision makers. However, the authors advise that management information systems are generally not designed to provide information for use in making instructional design and development decisions, and that cost and effectiveness analysis procedures need to be developed to provide data appropriate for course, unit, and module level decisions. The authors close with the recommendation that better procedures are needed for relating costs, effectiveness, and feasibility considerations for both ongoing and projected instructional alternatives.

A REVIEW OF THE CONTEXT OF COST ANALYSIS

Philip Doughty

Introduction

This section is sequenced such that cost analysis concepts are placed in the context of a more comprehensive systems analysis overview. The format is arranged in the following manner. First, there is a review of the principles of systems analysis modeling and model construction. Second, there is a review and description of a taxonomic classification of the analysis process. The third section contains a discussion of various subsystems which support a total systems analysis. The remainder is a review of some of the more promising applications in education of systems analysis techniques and models. Consideration is also given to applications of the analysis process to instructional development. Ordinarily, the review and description of systems analysis would follow the literature review section since many of the concepts were gleaned from the literature review. In this instance, the purposes, approaches, and descriptions are presented prior to the review to provide an overview of relevant concepts so the reader will have a better framework for interpreting the remaining sections.

Before discussing possible approaches to systems analysis in education, a clarification of existing terminology may be helpful. Literature on systems analysis is quite extensive and redundant. The serious investigator might consult one or more of the following sources as a starting point:

Churchman, Ackoff, & Arnoff - Introduction to Operations Research (1957)
Frank W. Banghart - Educational Systems Analysis (1969)
Karl Seiler, III - Introduction to Systems Cost Effectiveness (1969)

Each of these authors has contributed significantly to the state of the art as it now exists. The definitions and classifications of analysis which follow, however, are not germane to any single author or text, but are a result of a synthesis of many.

The term "systems analysis" is used throughout this review to define a broad range of possible analyses. Other similar terms (operations research, operations analysis, cost-benefit analysis, etc.) used in this section or by referenced authors differ in matters of degree, emphasis, and content. The important characteristic they have in common is the emphasis on making comparisons systematically in quantitative and qualitative terms using logical sequences that can be retraced and verified.

The term "analyst" is used throughout the paper to denote an individual or team of individuals interested in the process of systematically examining objectives, policies, strategies, costs, effectiveness and feasibilities of teacher education. "Analysts" may also be evaluators, designers, developers, or instructors, but application of the process of systems analysis also makes them analysts. (No degree of proficiency is implied!)

Analysis of instructional alternatives is the focus of the power of systems analysis. It is from results of careful systematic analysis that the alternative showing the greatest promise can be indentified. The results of existing approaches in teacher education and the potential of new techniques can be compared, priorities can be set, and decisions can be made on the basis of comparative data from the analyses.

A perusal of the literature on systems analysis shows considerable disagreement among systems theorists on definition of terms. Many writers use the term, evaluation, when they mean analysis. Evaluation for the purpose of this paper, is defined as the judgment of the success or failure of a strategy or program. Analysis is a process of systematically asking questions about the benefits (outcomes-effectiveness) and total dollar cost implications of specified programs and assembling information that will help answer those questions. Some writers use the terms cost effectiveness, cost benefit, and cost analysis interchangeably. An attempt will be made to differentiate between these and each will represent a type of analysis with its own distinct factors and constraints. A good discussion of the semantics problem, if you can modify the context, can be found in Quade's Analysis for Military Decisions (1964, pp. 2-12).

Systems Analysis Modeling

In its broadest sense, the goal of systems analysis is to aid in the formulation, analysis, and choice of future courses of action. Systematic consideration of any problem of choice requires that some model be used. The model may be unstated and undeveloped, but if a decision maker does something other than throw a coin in the air to make a decision, a model of some type is being employed.

Whether or not one model is better than another is determined by its ability to provide a better description, explanation, or prediction. The model providing the best information should then logically lead to better decision making.

It is important to emphasize that an analysis model is not a flowchart or verbal description, but a process. Flowcharts, descriptions, and examples only serve to better communicate the purpose and practice of the process.

Several approaches to systems analysis modeling have been developed and discussed by many authors. Churchman (1957), Quade and Boucher (1968), Seiler (1969), and Fischer (1971) provide thorough model design guidelines although none are specifically intended for educational application.

The systems analysis process involves a series of iterations through several phases. Quade and Boucher (1968) describe the phases as formulation, search, evaluation, interpretation, and verification.

The formulation (conceptual) phase involves the definition of the problem, clarification of objectives, and the establishment of evaluative criteria. The search (research) phase includes the collection of data,

the establishment of predictive relationships, and the generation of alternative strategies that might have some chance of solving the problem.

The evaluation (analytic) phase involves the building of various models, the use of those models to predict the consequences of the selection of each alternative, and the comparison of the alternatives in terms of those consequences. The interpretation (judgmental) phase involves the use of the predictions obtained from the models and any other relevant information to compare the alternatives, derive conclusions about them, and suggest a course or courses of action. The verification (validation) phase involves testing the assumptions, conclusions, and recommendations.

Each of the phases is important, but Quade recommends particular emphasis be placed on the formulation phase.

> It is difficult to overemphasize the importance of a careful formulation. It should identify the sub-problems involved, isolate the major factors, develop a vocabulary for dealing with them, stretch out the relationships between the variables as they appear, and even arrive at a tentative set of conclusions. The idea is to make clear the structure of the analysis. But more importantly, it offers a concrete hypothesis for others to probe (Quade, 1964, p.307).

Lovell's (1971) description of the application of the analysis process to elementary and secondary education includes both considerable discussion and extensive graphic representation. Application of a similar process in a teacher education context is not implied but is a definite possibility.

A discussion of the major considerations of systems analysis cannot be complete without giving due consideration to the shortcomings of the process. No analysis can solve all problems or answer all questions. Analysts and decision makers must be aware of the limitations. Quade and Boucher (1968) and Fisher (1971) include the following in their discussions of common pitfalls:

1. Failing to allocate and to spend enough of the total time available for a study deciding what the problem really is.
2. Examining an unduly restricted range of alternatives.
3. Trying to do too big a job.
4. Determining objectives and criteria carelessly.
5. Using improper costing concepts.
6. Becoming more interested in the details of the model than in the real world.
7. Forcing a complex problem into an analytically tractable framework by overemphasizing ease of computation.

8. Failing to take proper account of uncertainty.

Model Building

Fisher (1964) comments that a model, depending on the nature of the problem, can be formal or informal, highly mathematical or not at all mathematical, computerized or manual. He emphasizes that a model need not be highly sophisticated or formal to be useful. He lists several points that a model builder should keep in mind:

> (1) Model building is an art, not a science. It is often an experimental process. (2) The main thing is to try to include and highlight those factors which are relevant to the problem at hand, and to suppress (judiciously!) those which are relatively unimportant. Unless the latter is done, the model is likely to be unmanageable. (3) The main purpose in designing the model is to develop a meaningful set of relationships among objectives, the relevant alternatives available for attaining the objectives, the estimated cost of the alternatives, and the estimated utility for each of the alternatives. (4) Provision must be made for explicit treatment of uncertainty. (5) Since by definition a model is an abstraction from reality, the model must be built on a set of assumptions. These assumptions must be made explicit. If they are not, this is to be regarded as a defect of the model design (Fisher, 1964, p. 10).

The model selected by an analyst following such guidelines depends on the purpose of the analysis as well as the types of criteria established and types of data obtainable. Two which are appropriate for educational purposes are classified as mathematical models and tabular display (matrix) models. Mathematical models are suitable when all the evaluative criteria can be quantified and are comparable. For most educational purposes, this is not possible. A tabular display model allows more flexibility so alternatives can be compared using various quantifiable but uncomparable measures in addition to qualitative statements of relative effectiveness, efficiency, etc. Unquantifiable measures are often highly valued and demand consideration so it is usually necessary for a tabular display model to be used in most educational systems analysis comparisons. Some qualitative analyses can be included in a formal model and additional discussion on nonquantitative considerations can be included in both the analytical and evaluation phases.

Uncertainty

Predictive analyses of instructional alternatives include many elements of uncertainty. These include uncertainty about the state of the world, higher education, or teacher education, as well as uncertainty about change elements that might exist even if environmental uncertainties do not exist. Quade (1963), Fisher (1964) and Hitch (1955) have written extensively on the topic as it relates to military analysis and much of this can be applied to education analysis.

A technique for treating uncertainty that appears to have general promise for education is sensitivity analysis. For variables about which the analyst is very uncertain, application of this technique will at least provide several estimated values rather than one expected value. A range of values for a variable may be plugged into a model to see what effect each will have on the outcome. If there are many of these variables, considerable calculation is required and the question then arises as to the value of the exercise in relation to the usefulness of the information generated.

Validation

Accuracy of prediction is an indicator of the validity of a prediction model. It is difficult to validate a model without actually developing and testing generated alternatives. Cost and time constraints usually prohibit this type of testing. This is not an uncommon circumstance. Quade (1963) suggests several criteria that can be used to check the validity of many types of models. He asks,

> (1) Can the model describe known facts and situations reasonably well? (2) When the principle parameters involved are varied, do the results remain consistent and plausible? (3) Can it handle special cases that we already have some indication as to what the outcome should be? (4) Can it assign causes to known effects? (Quade, 1963, p. 20).

Analysis Of Systems Analysis

Classification of the concepts, purposes, and approaches to systems analysis leads to a multiple category taxonomy of terms. This section contains a brief description of five interrelated, non-sequential, relatively exclusive categories. Each is defined and broken into subcategories. The five categories are: (1) level, (2) function, (3) purpose, (4) approach, and (5) type. Before an educational planner or designer can begin to even conceptualize a model or an analysis, a "thorough understanding" (apologies to Robert Mager) of these categories is essential.

Level

When developing a model, one of the first determinations an analyst must make is the level of information the model must provide for intended decision makers. If the model is to be used only by top level administrative decision makers (legislature, Board of Regents, school board, university president) the depth or detail of concern need not be extensive. If the data will be used by department chairmen, instructors, and instructional designers, the level will need to reach substantially below the program level, perhaps to the level of a unit of instruction or even the performance objective level.

It will require considerably more time and resources to collect and analyze data at the lower levels, so if there is no need for detailed

cost, effectiveness, and feasibility data, the analyst needs only to assemble information at the appropriate higher level of interest. The key to determining the appropriate level then is ascertaining the level of specificity of information that the model must provide.

Consideration of the following questions will assist in that determination.

1. Who will be using the information furnished by the model? The analyst must identify the decision makers who have the authority to initiate, terminate, and alter policies governing the alternatives being analyzed. In teacher education this authority will undoubtedly rest with more than one person (professor, department chairman, superintendent, dean, vice-president). It is important to know how these people make decisions so that the results of the analysis can be properly structured and presented.
2. Who is to be implementing the model?
3. How is it to be implemented (hand calculations or sophisticated electronic hardware)?
4. What is the complexity of that being represented by the model?
5. How often is the model to be used?
6. What degree of precision does the model need to have in relationship to the real world?
7. How accurate is the data that will be used in the model?
8. How accurate does the data need to be?

Function

There are several activities to which systems analysis contributes. Each has a specific purpose and an identifiable outcome, but they may also be closely dependent upon one another. The four identified are control, planning, evaluation and development.

Control. The educational manager, be he (or she) president, dean, or instructor, must be able to effectively manage the resources for which he is responsible. This management cannot be done after the vouchers or purchase orders have been signed but must begin in advance of all signing of contracts. Cost control practices in particular can only be implemented before the fact. However, after-the-fact cost and effectiveness assessment information will help decision makers control ongoing and future programs.

Planning. Cost analysis information allows planning for future changes in allocation of resources for a course or a program. This information can allow for planning of potential expanded uses of a teacher center or for expansion of a course or unit of instruction. It can also provide more general information for use in planning adaptations of a technique such as an individualized approach to other suitable learning situations within a university. General analyses can also produce a range of potential courses of action by means of a systematic study of all alternatives.

Evaluation. After-the-fact cost analysis data are valuable for use in comparison with planned costs so that better subsequent planning data can be used for decisions about the value or utility of future revisions and new projects. Greater instructional effectiveness as well as more efficient research and development efforts can also be attained through the use of after-the-fact analysis information as one basis for decision makers judgments of a program's success or failure.

Development. Costs and effectiveness analysis information can assist in more efficient and effective development of materials and procedures for instruction. Information can also assist in the design of better plans, better management techniques, and the development of better systems and techniques for producing and reproducing instructional materials.

Purpose

In addition to levels and functions, three general purposes of systems analysis must be considered because of the valuable guidelines they provide. The three are related temporally and may be highly interdependent.

Descriptive analysis. Descriptive analysis is employed to describe ongoing programs. Accounting and assessment data acquired in the application of this type of analysis provide the bases for all other analyses. Cost analysis (accounting) is used to measure dollar costs and relate costs to output. Effectiveness (benefit) analysis is conducted by measuring cognitive and non-cognitive changes in learners (output) in relation to stated objectives.

Predictive analysis. Predictive analysis is used by those who need to ascertain costs and benefits of proposed alternatives. This requires consideration of prior costs as a basis for a predictive cost analysis. It also necessitates determination of objectives, strategies, required resources, cost estimating relationships, and the costing of resources. Effectiveness analysis is used to predict the level(s) of output of effectiveness of each alternative. Predicting various levels of effectiveness based on previous studies is one of the most difficult and least precise activities a systems analyst must perform.

The inexact nature of such activities oftentimes leads to condemnation of the entire process; but systems analysis is only intended to reduce, not eliminate the margin of error in the decision-making process.

Comparative analysis. As stated earlier, the ultimate goal of systems analysts is to make comparisions. Comparative analyses are based on both descriptive and predictive analysis. Ex post facto comparisons can be made by using data from properly designed descriptive analyses. A priori comparisons make use of predictive analyses which in turn are built upon descriptive studies. It is for this purpose that a distinction needs to be made between the various types and between approaches.

There are several more specific purposes for which systems analysis can be used. One is the allocation of resources among identified objectives. Another is the choice of alternative means to meet the given objectives. A third is the assessment of the worth of different objectives. A fourth purpose is to provide for the systematic generation of alternatives which were not originally identified.

Each of these will be discussed more fully in later sections.

Approach

In comparing alternatives in terms of the data generated by the analysis model, several different conceptual approaches may be used.

Fixed effectiveness approach. One approach is to specify a desired level of effectiveness or output and then examine the cost of alternative means of achieving that specified level. The purpose is to identify the alternative or combination of alternatives which will reach that level with the lowest expenditure of resources. This is appropriate if defensible, comprehensive indicators of effectiveness can be identified. Most educational alternatives bring about learner change of several kinds so identification of such a measure is speculative at best.

Fixed cost approach. Another approach is to fix a single budget level (cost) and then examine the level(s) of effectiveness that might be achieved through different alternatives. The intent is to identify the alternative or combination of alternatives which will produce the highest effectiveness.

A third hypothetical alternative allows both the cost and effectiveness to vary. This permits the naive idealist to request, "I would like to get the maximum possible effectiveness for the least possible cost." Carried to its logical conclusion, the approach would result in infinite effectiveness for zero cost. In reality it reverts back to the fixed cost approach, where, at some stage, limits are placed on the amount of resources available.

Carpenter and Haggart (1970) recommend the fixed cost approach because it focuses the attention of decision maker and analyst on the effectiveness of alternatives which is by far the most difficult phase of the analysis process. The problems associated with comparing effectiveness of instructional alternatives would indicate that the fixed cost approach is more suitable for educational purposes. Costs are usually fixed by adjusting the dimensions of each alternative (such as the number of students enrolled) so that each alternative incurs approximately the same total cost over a common time period.

Type

Six types of analysis of educational programs in descending order of sophistication will be described. Some mention of analytical approach will be included where appropriate. The types of analysis are: (1) Cost benefit analysis, (2) Cost effectiveness analysis, (3) Unit cost analysis, (4) Cardinal weighting analysis, (5) Ordinal ranking, and (6) Best guess decision making.

Cost benefit analysis. Cost benefit analysis is an analytical approach to the selection of alternatives on the basis of comparisons of benefits and costs. The approach is appropriate only when alternative outputs can be quantified in dollar terms. This is the only type that incorporates value judgments into the analysis. Estimates of social value of the output(s) of each alternative are given dollar values so that the benefits of each alternative can be expressed as a single measure -- dollars. This is also the only approach which will permit direct comparisons of alternatives with different objectives. By translating the outputs of each alternative to dollar terms, common comparisons are possible.

A cost-benefit ratio for each alternative can be derived by dividing the value of the benefits by the value of the costs. However the costs and benefits are determined and computed, most authors indicate that total benefits should be greater than the total costs (B-C ratio greater than 1.0) if a program or alternative is to be considered. Computations must be made and a benefit-cost ratio derived for each alternative before comparisons can be made. Results or changes that are not related to specified objectives are not considered benefits. Many of these by-products or spillovers can be identified and analyzed but only as supplementary gains, not as benefits.

McKean (1958, pp. 34-37, 107-113) and Hitch and McKean (1960, pp. 166-167) have written lucid and enlightening discussions of the possible treacherous nature of ratios. Eckstein (1958) on the other hand, bases many of his analyses on the development and use of ratios.

Dorfman's analysis is perhaps most insightful. "The heart of the matter lies in deciding what benefits should be included and how they should be valued. The debate about benefit-cost analysis centers on the question of whether the social value of benefits can be estimated reliably enough to justify the trouble and effort involved in a benefit-cost computation (Dorfman, 1963, p. 8)."

New statistical models and techniques hold great promise as solutions to some of the problems involved in calculating educational benefits in dollar terms. Additional research and development will help as the art becomes more scientific and better data are obtained.

Cost effectiveness analysis. Cost effectiveness analysis is appropriate when a market evaluation or value can not or should not be placed on the outputs of the alternatives, but the resources (inputs) of the alternatives can be evaluated or measured in market prices (dollars). The approach is derived from non-educational settings where the problem is to select a strategy or product from a set of alternatives designed to achieve specified objectives.

The recommended approach for education is to construct fixed or equal-cost alternatives so that each will require approximately the same total cost for a fixed time. The projection of estimated costs of each alternative can be done with more confidence than projection of effectiveness, particularly since no single measure of effectiveness will reflect the total output of any instructional alternative.

Cost-effectiveness analysis is most useful for resolving problems that hinge on allocation of resources because the techniques and systems needed for the analysis of costs are somewhat more sophisticated and better developed than are those for the analysis of effectiveness. Stated differently, it is usually easier to specify the cost variables in an educational system than it is to determine the larger set of variables needed to account for effectiveness. It should be emphasized that the cost-effectiveness approach will provide little help in determining whether an alternative or an objective is worthwhile. Value judgments of this sort are left to decision makers and are not generally identified and quantified as in the cost benefit approach. However, many of the evolving needs assessment and futures generating (Delphi, etc.) processes have potential for assisting in this "data gathering for value decisions" area.

Unit cost analysis. Unit cost analysis helps a decision maker see what components comprise the cost for a course, alternative, or a competency and how changes in these components will affect cost levels. Unit costs allow a decision maker to predict future costs when changes are introduced in faculty salary, faculty work load, enrollment, student credit hour allotment, or other variables.

Quantitative and qualitative effects of changes in alternatives are not usually measured or reflected in unit costs. Most unit cost analyses are based on jurisdictional costs (usually derived from line-item budgets) which do not reflect the total costs required to realize some specified outcome. They are far too general to be used as a basis for cost benefit or cost effectiveness analysis. Those which do reportedly use functional costs (related to output) are able to provide the kinds of information that can greatly aid the decision making process.

Care must be taken to avoid misconceptions that often result from the use of unit cost analysis data. Use of unit cost alone emphasizes the fiscal aspect to the exclusion of the effectiveness of an alternative. There is a great temptation on the part of decision makers to create more "efficiency" through cost reductions than to improve the effectiveness. It is also easy to make improper comparisons between courses, curricula, or departments which are not comparable in nature.

Although unit cost information has been misused and abused historically, this need not keep unit cost analysis data from providing valuable information. Proper design and implementation of unit cost analyses and a thorough understanding of the nature of unit costs by decision makers can result in better decisions.

Cardinal weighting analysis. Cardinal weighting analysis departs from the quantitative approach except for the calculation of direct costs for each alternative. It relies on identification and specification of the advantages and disadvantages of each alternative. The more sophisticated analyst may consider cardinal weighting as amateurish. But the listing and weighting of advantages and disadvantages of alternatives, even if done on a value judgment basis alone, will most probably result in more clarity and honesty in alternative selection.

The method is quite simple but can be very effective if properly applied. The analyst begins by listing the advantages of an alternative. Every advantage for an alternative is weighted by awarding each a number from 1 (lowest) to 10 (highest) in value. This process is followed for each advantage and the points are then added. The procedure is repeated by listing disadvantages of the alternative but with the values of the weighting scale running from 1 (least disadvantageous) to 10 (most disadvantageous). A cardinal weighting index for the alternative can now be obtained by subtracting the total disadvantage points from advantage points. The procedure is repeated for each identified alternative and a comparison can then be made between the cardinal weighted indices. The alternative with the greatest number of points should be the most valuable one. If the cost of that alternative is the same or less than lower weighted alternatives, the recommended decision becomes obvious.

This procedure, is useful only if: (1) the analyst lists as many as possible of the advantages and disadvantages of each alternative, (2) the weights are objectively assigned to each advantage and disadvantage, and (3) the decision maker realizes that the results of the analysis are only as useful and valid as the lists are comprehensive and the weightings objective.

This procedure will at least clarify the issues involved when considering alternative approaches or programs and will lend assistance when the data and personnel are not adequate for more sophisticated analyses.

Ordinal ranking. Ordinal ranking of alternatives is an analytical procedure in which alternative programs are ranked in order on the basis of predetermined criteria. Criterion can be determined in many ways by many and diverse interests. How the criterion is determined is as important as the ranking process. The criterion might be developed on the basis of total or direct costs, time, number of key personnel or learner satisfaction. Agreement on each criterion measure or basis of the ordinal ranking should precede the application of the analysis. Establishing criteria after the initial stages of the analysis have been completed is a less than objective approach. However, if new and valid criteria are discovered while doing an analysis there is nothing to prevent additional analyses being made using the new criteria.

Best guess decision making. Best guess decision making need not be a totally unobjective process. A statement of the reason or reasons for recommending a given alternative can be based on considerable research and evidence. The reason may be logical, psychological, political, or otherwise. Much more sophisticated analysis may have preceded the solution, but if time and other factors prevent a more detailed documentation, a simple statement of why a particular recommendation was made will be of some help.

The purpose of this section on analysis of analysis was to do just that -- to break up the process in order to view the nature and relationships of its components. To complete the picture, a look at the way these components are combined to form subsystems is necessary. A complex problem may require that many specific analytical models be developed. Other problems may only require one comprehensive model. Three primary analysis

subsystems are discussed in the following section. Each is an example of an important class of subsystems.

Analysis Subsystems

Cost Model

Traditional and programmed budgeting. There are many limitations in using a traditional educational budget as a base for a cost model. Briefly, the primary problems involved in using a traditional budget are: (1) the difficulty of relating the budget to goals or objectives; (2) the difficulty of allocating resources; (3) the difficulty of projecting budgets and costs beyond the current budgeted year; (4) the impossibility of relating costs to outcomes; and (5) the lack of integration between planning and control (including budgeting) and the instructional or program element of an institution.

Most educational accounting systems are designed to insure budgetary compliance rather than for determining program costs or measuring instructional effectiveness. Budgets are purposely designed to identify appropriate sources of funds and accounting for the source of budgetary expenditures rather than assisting in the allocation of resources. In order to generate alternative means or ways to accomplish some given outcome, a decision-maker must be able to relate costs or expenditures to outcomes. When this can not be accomplished, the generation of feasible alternatives to the achievement of objectives is not possible.

Construction and use of the traditional budget has historically been the domain of budget officers or finance experts and communication between them and those responsible for instruction has been minimal. Finance experts have not been expected to be responsible for instructional decisions and those with instructional responsibilities have avoided planning, allocating, or relating costs to outcomes.

The purpose of the relatively new (to education) program planning and budgeting system (PPB) approach is to provide the basic and essential information needed by all decision-makers so that they can analyze feasible alternatives and make decisions based on more appropriate data. It should be noted that most attempts to implement such a system in education have not centered around the information needs of teachers or program designers.

The absence of a PPB system does not eliminate the possibility of an analysis study being conducted. The task of defining, costing, and analyzing the output of ongoing alternatives which have not been defined in a program format is difficult however. A well designed cost analysis model will assist in accounting for costs of ongoing programs as well as in predicting costs of potential programs.

There are ample discussions in the literature of the history, theory, applications and shortcomings of program budgeting. Several of the more concise descriptions have been written by Banghart (1969), Haggart et al. (1969), Levine (1969) and Pfeiffer (1968).

Cost considerations. As with the general systems analysis model, design of the cost model requires that analysts carefully consider many factors. Several of these, i.e., inheritance, research and development, and time, merit brief discussion.

Inheritance. Inheritance consists of previously procured tangible assets such as facilities, equipment (hardware) and software. The cost over and above the resources that can be inherited is the additional or incremental cost that will be charged to a new system or program. The goal of the analyst is to minimize this incremental cost by building on existing programs where possible and sharing the inheritance of other programs.

Research and Development. Care must be taken to distinguish between research and development, research in development, and research on development. Generally speaking, only those research and development costs that contribute directly to program goals should be included in the cost model. If resources are required for more basic research or development, those costs should be singled out from normal research and development costs and reported separately.

Time. There are several time functions that must be considered in educational cost analysis. Four of these are uncertainty, discounting, depreciation, and obsolescence. Each has an impact on total cost but determining the degree of impact is quite difficult. Few examples of applications of these cost functions exist in education literature, but military and industrial applications do provide guidelines. Uncertainty was mentioned earlier under sensitivity analysis and will not be discussed here but the importance of its consideration cannot be overemphasized.

McKean (1958, pp. 76-92) has written one of the better discussions on the various approaches and rationale to discounting. Hitch and McKean (1960, pp. 205-218) present several arguments in support of the process of discounting future cost. They comment that acquisition and use of a monetary unit in the present will cost less than acquiring and using it in the future.

In addition to the question of whether to discount or not is the controversy over the appropriate rate to use. Various federal agencies use discounting techniques in their program plans, but the rates they use to discount vary widely. The rationale used for establishing a given rate is usually quite subjective and the use of the process in any but the largest programs does not appear to be worth the time and effort.

Depreciation and obsolescence in an educational setting are valid time-based cost functions. Determination of depreciation schedules based on use, output, and obsolescence approaches true depreciation costs more closely than the present straight-line depreciation schedules now being used by most educational cost analysts. When technological innovation is accelerated or remains at a high rate of acceleration, the expected life span of some equipment is shortened by the increased rate of obsolescence. Depreciation is usually considered a fixed cost. But consideration must be given to the fact that increased use affects the value of equipment by changing the expected life span. Straight-line computations of depreciation (for hardware and software) are precise but they are often misleading when used as the only basis for depreciation schedules.

Many analysts use amortization accounting instead of depreciation. This requires making annual payments into a sinking-fund to replace original equipment at the end of its economic life. Interest earned on money in the sinking-fund aids in accumulation of replacement money. However, this process is not usually feasible in public education institutions.

Cost categorization. One of the first tasks to be performed in conducting a cost analysis or in designing a cost model is that of defining and listing all the major cost categories of resources required by an instructional alternative. These categories serve to specify the segments that need analysis. Identification and tabulation of such interrelated and non-exclusive cost categories as joint costs, fixed and variable costs, and recurring and non-recurring costs will help distinguish between instructional alternatives on a functional cost basis. In this way, predictive costs can be estimated more accurately and differential cost effects, both in magnitude and kind, can be identified as program elements are varied within and between alternatives.

Results of any cost analysis can be easily biased by the exclusion of categories or the inclusion of inappropriate cost categories. Certain types of costs (sunk costs, discounted costs, and incremental costs) can easily invalidate an otherwise good cost model if handled incorrectly.

In order to accurately predict total system costs, expenditures need to be categorized in two classes -- non-recurring and recurring -- so that long and short-range cost predictions can be made. Non-recurring costs include such areas as research and development activities and the initial investment to implement the results of those activities. Among the list of research and development costs are preliminary research and design studies, design and development of subsystems, and system evaluation costs. Initial investment includes costs for training, equipment, facilities, and installation expenditures. Recurring costs are composed of annual operation costs needed to maintain and evaluate a program. This includes items such as salaries, replacement and maintenance of equipment, and expendable supplies.

Analysts also need to know which costs included in an alternative are fixed (i.e., would not change because of changes in level of activity) and which costs are variable (i.e., costs that respond to alterations in quantity or quality of operation). Such a separation provides the base for estimations of how costs would be modified or what the marginal cost effect would be as a result of changes in enrollment, instructional strategy, criterion levels, etc.

The Rand Corporation employs a method of cost accounting which separates total system costs into three classes. The three classes can represent overlapping time-phased resource requirements of an instructional design project. The classes categorize costs by: (1) Research and Development - which includes all costs necessary to bring the system into readiness for operation (non-recurring); (2) Investment - which includes all non-recurring costs required in the process of phasing a system into operation, e.g., facility, equipment, and training costs and, (3) Annual Operating - which includes all costs necessary for the operation of the system, e.g., salary and allowances, training, and maintenance costs (recurring) (Petruschell & Chester, 1963).

The general scope of a cost model can be displayed in a systematic manner by using a cost table or matrix. The matrix approach classifies all general cost elements horizontally and system or phase elements vertically. For design and development purposes, the matrix could include the terminology of specific hardware and software components as well as consideration of various time or function phases. Examples of this matrix format will be provided in a subsequent section devoted to a generic cost model for teacher education.

Cost estimating relationships. The theory of cost modeling rests basically on two components or relationships. One concerns the matter of deciding what is to be costed and charged to an alternative. This task consists of listing and defining the appropriate categories of total dollar cost. The other concerns the technique of cost prediction. These relationships are generally termed cost estimating relationships. One relationship is the estimate of the cost per unit of each resource. The second type is the estimate of the number of units required to meet the necessary prerequisites for each alternative. These relationships are used to relate required resources to their costs. In developing a predictive cost model, data from past experience or ex post facto cost analysis information can be used to derive many of these estimating relationships.

Ex post facto cost analysis or cost accounting does not require cost estimating relationships because actual costs are used rather than predicted costs. Data from cost accounting or after-the-fact cost analyses do provide valuable insight and guidelines for establishing estimating relationships for predictive cost models. These data are of little use, however, when a newly designed alternative includes few of the components of the operational program. Once a relationship for estimating the unit cost of a resource has been established, either from prior cost information or from estimates, the next step is to attempt to determine how many units of this resource will be needed to meet the requirements of the alternative.

A predictive cost model must serve as a device for estimating the costs of future alternatives by translating the descriptions of these alternatives into requirements for resources and then transforming those requirements for resources into costs. In order for the predictive cost model to be useful, this translation of alternatives to resources to costs must be relatively simple and explicit or so mechanized and flexible that users will not view the model as being too restrictive or difficult.

Resource analysis. Several process models designed to assist in the allocation of resources to specified instructional strategies are in formative stages of development. A model for analyzing resource utilization of on-going instructional programs has been developed by the Evaluation Training Center of the College of Education at Florida State University. Precise specification of instructional resources being used allows model users to apply much simpler costing procedures to ascertain program costs.

Developed under the sponsorship of the Research and Development Program of the Florida Department of Education, the model also assists teachers,

instructional designers, and analysts to predict costs of proposed instructional alternatives. Through a series of relatively well defined, interrelated procedures, the model user is able to allocate resources by analyzing the type and domain of specified instructional objectives, the instructional activity selected as appropriate for the objective(s), and the resource requirements specified by the activity. Unfortunately, the cost analysis procedures for the model have not been well enough developed to be of immediate use (Beard et al., 1971).

MODIA. The Rand Corporation's MODIA (A Method of Designing Instructional Alternatives) model is another process approach to designing instructional programs. It consists of a series of procedures and tools that allow an instructional designer to examine alternative strategies during a planning stage and be able to predict the impact of resource allocations on program outcomes (Carpenter, 1972). Current emphasis of the model has been on the use of technology in designing instruction for formal technical training in advanced military training settings. A more detailed analysis of this model is contained in the following section of this report.

Procedures like these will make instructional design and instructional resource allocation procedures much less subjective and, at least theoretically, lead to greater instructional effectiveness and efficiency.

Cost analysis texts. A prospective cost analyst seeking assistance from the literature can easily become overwhelmed by the volumes devoted to costing, cost accounting, budgeting, etc. Although not specifically written for education, two of the more readable and useful sources are books by Fisher and Seiler. Application and adaptation of their guidelines and procedures should assist greatly in designing a viable cost analysis process model.

Gene Fisher (1971) relies on the military for examples and applications for his book Cost Consideration in Systems Analysis. The major emphasis is on assessing the cost implications of alternative future military capabilities. He does not discuss cost accounting, cost estimating for future operations, or cost analysis of detailed design activites, but much of what is included is applicable to these areas. Translating his military verbage into educational jargon is fortunately more of a challenge than an onerous task. Karl Seiler's (1969) relatively brief (108 pages) text, Introduction to Systems Cost-Effectiveness, assumes a basic understanding of calculus and probability theory, but mathematical applications are minimal and literary explanations are well done and ample. From the viewpoint of a cost model builder, the most important guideline to be gleaned from these texts is that the cost-related information for each alternative must be transmitted to decision makers in a format that will accurately represent the alternative and permit meaningful comparisons.

Effectiveness Model

The analysis of effectiveness of educational programs or alternatives should be as vigorously developed as the analysis of the resources used

to implement a program. The uses of systematic techniques for planning an instructional alternative should lead to the expansion and improvement of ways to relate the quantity and quality of the output of the alternative to the resources used to create that output. Decision makers also need criteria other than cost for measuring productivity or usefulness. The criteria for these outputs (other than cost) can be grouped under the general term effectiveness. Just as cost is a measure of the resources that comprise an alternative, effectiveness is a measure of the output of that alternative. If possible, effectiveness is measured in terms of performance or change, but it can also be measured in general terms with qualitative interpretations.

Like the cost model, the effectiveness model can be described in terms of its elements and methods for identifying and predicting the measures of those elements. The kinds of components that can be used are as numerous as there are kinds of systems and kinds of measures. The basic elements, by necessity, must oversimplify a very complex real world. What is required of these components is that they usefully express the relation between measures and performance, or more specifically the capability of the alternative to achieve the specified objectives.

Each instructional alternative should be comprised of multiple objectives aimed at achieving specified goals. It is important to determine whether those objectives are unique or if they actually form a hierarchy with a single, assessable objective at the top. If a single measure of effectiveness can be determined from a set of objectives, it is much easier to measure and report. Quade suggests several methods for combining and eliminating multiple objectives: ".....elimination of any objective that is important only as a means to another objective;.....elimination of any objective that will be unaffected by a choice among alternatives;..... selection of a higher level objective to which all of the competing objectives are means (Quade, 1964, pp. 159-160)".

Evaluative criteria. In order to comprehensively evaluate an ongoing instructional system or to compare feasible alternatives, standards for judgment must be established. Such standards are necessary to help determine the relative importance of various outcome measures and to assist in establishing appropriate or acceptable levels of those measures.

An instructional system evaluation plan must consider not only learner performance but cost, time, and value criteria as well. Effectiveness criteria stated in terms of learner performance must reflect standards or norms selected by decision makers. The process used to establish standards and validate measures oftentimes requires considerable attention by many parties.

Consideration of costs, as stated previously, must be made in relation to other factors such as resources, outcomes, and constraints. Time is also closely related to cost, effectiveness, and efficiency. Considerations of time in relation to learners includes measures of total lapsed time (beginning and ending dates), learning time (actual time spent in learning), and retention over time (reliability-stability). Value or utility are the ultimate criteria since the payoff of an alternative to the learner and society must be eventually measured in those terms.

Carpenter and Haggart consider the setting of effectiveness criteria to be a high priority task but one that must be accomplished with care. They recommend "Whatever criteria are chosen, they should only provide general guidelines to the planner, rather than draw fine lines between the acceptable and the unacceptable. This is because the measures available are subject to error and, at the same time, are only proxies for what we would really like to assess.....student learning (Carpenter & Haggart, 1970, pp. 10-11)".

The value-added concept of educational assessment is also an important consideration. The concept does not lead to judgment of alternatives on their outputs alone, but by their outputs relative to their inputs. Learner change (in relation to learner capability) attributable to the effects of an alternative is the sought after measure of educational value added.

As stated previously, no single measure of effectiveness can tell the entire story of the value or worth of an alternative because any instructional alternative generally promotes several different kinds of change in learners. Since the changes are varied and differ in kind, no single proxy measure can be used to represent all the changes attributable to the alternative. The effectiveness model should therefore allow output measures to be displayed as a set of measures and indicators.

Further discussions of evaluative criteria can be found in sections in the texts by Quade (1966, pp. 8-12) and Banghart (1969, pp. 42-46).

Prediction. There is one major concern about the design and use of effectiveness modeling procedures. A simulation of costs and effectiveness of most instructional alternatives is difficult since valid predictive relationships between instructional inputs and process on one hand and instructional results or outcomes are nonexistent. Ex post facto effectiveness analysis is less speculative but still contains problems of measurement, attribution, and comparison. Barro has stated the problem quite nicely:

> The methodology of resource and cost modeling is relatively advanced as a result of much work in other fields and is available for application to school district planning. The methodology of "effectiveness" modeling is relatively underdeveloped both in education and in other fields. In education, in particular, conceptual advances and considerable empirical research will be required before it is possible to establish valid predictive relationships between program characteristics and educational results (Barro, 1969, p. 65).

Perhaps the best that can be accomplished in predictive comparisons of the effectiveness of instructional alternatives are qualitative estimates of the degree to which each alternative will contribute to the achievement of specified objectives. Prior experience and data from related studies will help with these estimates but they will nevertheless remain crude estimates for the foreseeable future.

Feasibility Analysis

The first section of this review was devoted to an analysis of systems analysis. Some mention was made about decisions involved in designing the structure of an anlysis and selection of an approach, but little was said about the basis for those decisions. Why is one approach more appropriate? Why is one type of analysis most suitable? What needs to be considered before goals and objectives are specified and alternatives can be considered? Each of these concerns and many others make up the domain of feasibility analysis.

Preliminary feasibility studies can lead to tentative determination of the level, function, purpose, approach and type of analysis. Once these tentative decisions have been made, emphasis can be shifted to the specification of goals and/or objectives for each alternative. Based on initial analyses and generation of alternatives, a decision maker often is forced to revise these program goals and objectives because of unrealistic expectations. Often both objectives and alternatives will need to be revised if a feasible solution is to be identified. This process of analysis, generation of alternatives, and subsequent revision should not be looked upon with disfavor. Hitch & McKean state: "It can in fact be argued that the chief gain from the systematic analysis is the stimulus that it provides for the invention of better systems (Hitch & McKean, 1960, p. 187)".

Feasibility can be broken into two general categories - constraints and capabilities. Both have been mentioned throughout this review but additional emphasis is warranted.

Constraints. Constraints can be defined as conditions existing both within and outside a system which can limit the achievement of specified objectives. These usually include time, manpower, political, financial, and other resources. Uncertainty, depending upon the nature of the problem, can also present serious constraints for the identification of feasible long range alternatives.

Determination and selection of a preferred alternative must, however, eventually be made from a set of feasible alternatives. Most professors or program managers can think of highly desirable alternatives that for obvious reasons are not possible. It is necessary for both analyst and decision maker to carefully consider any constraints or factors that determine which alternatives are feasible and which alternatives are not. Judy (1969) has outlined seven general constraint categories that can serve as review guidelines. He lists them as: (1) technological constraints, (2) policy constraints, (3) political constraints, (4) organizational, constitutional, and legal constraints, (5) resource constraints, (6) target constraints, and (7) imaginary constraints.

A constraint identification and analysis procedure such as one discussed by Beard et al. (1971, p. 43-46) will assist in developing strategies for determining whether a felt constraint is real and for dealing with those which prove to exist.

Capabilities. Just as constraints have the potential for inhibiting specified activites, capabilities have the capacity for assisting the accomplishment of identified objectives. Consideration of potential inherited facilities, equipment, personnel, etc. was discussed in the cost model section. An existing instructional system is a possible source of such inheritance or as a feasible future alternative. Carpenter & Haggart comment on such a possibliity:

> In educational planning, one alternative, simply to continue current practice, should be included for baseline data. Although this alternative will usually not incur the same cost as will the innovative programs being compared, it is important to know its projected future cost and effectiveness so that the added resource and cost requirements incurred by the innovative programs may be estimated. Then the incremental requirements that are associated with improved effectiveness will be known. (It often turns out that these incremental requirements are small compared with the requirements simply to maintain current practice, even though they might seem large when considered in isolation.) Thus the first step toward cost-effectiveness analysis must be to estimate the future resource requirements and effectiveness of current programs (Carpenter & Haggart, 1970, p. 12-13).

This applies only if continuation of programs is to be considered or if current programs indeed exist.

Documentation. Feasibility assumptions must be reported as part of an analysis just as are effectiveness and cost data. Regardless of the level, function, or purpose, upon the completion of a thorough analysis of alternatives, the analyst or analysis team is required to make recommendations based on the results of the analysis. Recommendations submitted by the analyst(s) must be accompanied by sufficient documentation. It should include the assumptions under which the analysis was made, the purpose(s) for the analysis, the methodology, the approaches used, and the conclusions reached. Any limitations that were placed on the analysis or any limitations that should be placed on comparisons of the alternatives should be listed so as to lessen the possibility that improper assumptions will be made by decision makers.

Carpenter and Haggart provide some guidelines for systems analysis documentation:

> In the presentation of the analysis, the qualitative considerations should be identified. This includes both those taken into account in the analysis and those that could not be made an integral part of the analysis inself. It is important to present the results of the formative quantitative analysis, and interpret the results with special attention to the assumptions and limitations of the analysis. In

addition, the analysts should attempt to identify the important qualitative considerations that the decision makers should try to take into account (Carpenter & Haggart, 1969, p. 5).

Results Of Applications In Higher Education

This section contains a selected review of reports of promising applications of systems analysis techniques and models. It is restricted to higher education and does not contain reviews of reports of elementary and secondary education studies nor those on post-secondary vocational education. However, much of the systems analysis literature in these areas is relevant to teacher education. Those of considerable interest include a Ph.D. dissertation by Lovell (1971), a report of the application of a predictive cost effectiveness model to Title I projects by Abt (1966), a much discussed paper by Alkin (1969), and a well written technical paper by Temkin (1970). Significant documents related to systems analysis of vocational education include a paper by Kaufman (1968), a report of a comprehensive study conducted in Pennsylvania (Hu, et al. 1969) and a report of a cost-effectiveness study conducted by Kraft (1969) in Florida.

Jurisdictional Cost Studies

A cursory review of costs studies conducted in higher education would lead one to believe that little remains to be done in the area of unit cost analysis. One study alone contains a selected annotated bibliography with eighty-six entries —— most of them published during the 1955-65 decade (Jones, 1965).

One major problem with most of these studies is that they are based on jurisdictional costs (costs within specific adademic units) rather than functional (output oriented) costs. Few of those using functional costs give any attention to research and development costs. Witmer (1967) and Chappell (1970) have discussed the history of the development of cost analysis and unit cost studies in higher education. Several of the more relevant studies are worth noting.

In a study published by the Western Interstate Commission for Higher Education, Kettler (1960) discussed the need for analysis of factors affecting instructional costs. His review of the early studies of these factors and of the nature of each factor served as the basis for his explanation of the effects of class size and faculty teaching load on instructional costs.

Procedures used at Wayne State University to compute direct cost of instruction for both department and student levels were reported by Hubbard (1962). He explained how personnel cost data are obtained through faculty estimates of percentage of time devoted to instruction, research, public service, administration, and other activities.

Russell (1959) used student credit hour production, instructional salary expenditure per student hour, and average size of classes weighted according to the number of credits each class carried as measures for indicating cost break-even points for instructional programs in universities.

Business and industry have employed break-even analysis for many years. Applications of the process to instructional development problems are rare. Translating a chapter on "Costs-Volume-Profit Analysis" (Li, 1966, pp. 344-372) into educational cost-effectiveness analysis terms results in considerable revision. The theoretical break-even point or region where cost and revenue projection lines meet becomes a much broader range in education where projected incremental costs, predicted effectiveness, and volume of students interact.

Witmer (1967) conducted an extensive unit-cost study of the University of Wisconsin system. He intended to use the data to investigate policy formulation, evaluate efficiency, study alternatives, and establish a base for a program budgeting system. His measures included faculty salaries, number of students per section, number of units per day and instructional strategy mix.

Although Witmer (1967) included efficiency as a concern in his study, a recent book is devoted entirely to the question of efficiency in higher education. Bowen and Douglass (1971) conducted a theoretical study on comparative instructional costs for different ways of organizing teaching-learning in a liberal arts college. Their approach to solving the problems of financial stringency in colleges and universities is to improve operating efficiency (the ratio between cost and output). The authors studied six different modes of instruction they felt were both educationally and economically promising. One of the methods is an eclectic model which builds on the strong compatible features of the other five models.

They considered gross estimates of direct instructional costs and indirect costs as well as some feasibility factors such as instructor acceptance of different modes of instruction. Their comparison approach simulates differential cost requirements as the modes of instruction are altered. From an instructional systems analysis viewpoint, their analysis and comparison of alternative cost is well worth noting.

Bowen & Douglass also listed nine potential alternative modifications of instructional resource allocations which could alter costs, thereby modifying efficiency. Each is a viable alternative, but for an analyst or decision maker to make the inappropriate assumption that each will either maintain or increase instructional quality under all circumstances is folly.

Modes of instruction examined in their study included some of the following input changes:

1. Substitute low-cost labor for high-cost labor, e.g., by replacing faculty time with assistant time or by increasing the proportion of junior members in the faculty.
2. Increase intensity of labor usage, e.g., by raising teaching loads for faculty.

3. Substitute student initiative for faculty supervision, e.g., by making study more independent.
4. Substitute capital for labor, e.g., by using the library or television in place of lectures.
5. Intensify utilization of capital, e.g., by using buildings and equipment more fully.
6. Substitute low-cost capital for high-cost capital, e.g., by employing temporary buildings, reducing standards of construction, or cutting down on expensive library acquisitions.
7. Change curricular mix, e.g., by increasing enrollment in low-cost subjects (sociology) and by reducing it in high-cost subjects (physics).
8. Reduce non-instructional services.
9. Spread overhead cost by increasing the scale of operation (Bowen & Douglass, 1971, p. 6).

Output comparisons consisted of unit cost data such as cost per class and cost per student course enrollment. Their only consideration of effectiveness was the assumption that quality of education would be maintained or improved with varying increases in efficiency. A comprehensive system analysis will need to consider differential effectiveness of alternatives to a much greater extent than did Bowen and Douglass. One of the planned activities of this project will focus on identifying and specifying feasible instructional resource allocation alternatives for teacher education.

Functional Cost Studies

Several of the more comprehensive educational costs studies, particularly those dealing with mediated instruction, were not based on traditional line-item budget reports. Jones (1965) reported on an instructional system development project conducted jointly by the College of Education, the audio-visual center, and the College of Business at Michigan State University. The actual costs of designing and implementing a number of courses by instructional television, as well as other instructional strategies, were identified and measured. In a later study (Jones, 1969), the Michigan State University closed circuit television system was analyzed in greater detail. More precise data on the costs of producing, distributing, and receiving the ITV programs being produced at Michigan State were obtained through interviews and analysis of various records. Hardware, software, and delivery costs were well documented, but little emphasis was placed on the analysis of developmental costs of instructional modules.

Another educational media cost study rivaling the Michigan State Study for comprehensiveness is one conducted for the United States Office of Education by General Learning Corporation (1968). The study reported an analysis of the costs of alternative instructional strategies which employ media.

The results of the study are reported in three volumes. The first volume consists of a set of guidelines for deriving the total cost of planning, implementing, and operating an instructional media system.

Volume I also includes a summary of cost comparisons of several types of instructional systems designed to perform the same task. It also includes recommendations which can result in cost savings when media systems are used. These recommendations are in the areas of media utilization, application of new technology, and educational system organization. Volume II consists of the technical material and data on which the cost comparisons are based, and Volume III is a report on computer assisted instruction.

Variables considered in the cost analyses include the average length of instructional units, quality of production, type of program, and the type of the media or delivery system employed. Media costs were based primarily on hardware cost rather than design and production of software.

Problems With Costs

To temper the zeal with which these analysts approached cost analysis, a comment on the shortcomings of cost analysis and unit cost data and the use of such data is in order. In a Journal of Higher Education article, Hull (1961) ably reviewed many of the undesirable characteristics of unit cost studies. He pointed out that unit cost data are quantitative and not qualitative. He also noted that present quantitative measures pertaining to educational outcomes are less than precise. He related that improper assumptions, interpretations, and comparisons can be made by well-meaning but misinformed decision makers. Hull also cautioned that the positive benefits of cost studies far outweigh the disadvantages and the need is for more refinement in unit cost study construction, more understanding of the nature of cost studies, and more careful consideration of limitations of cost studies by decision makers.

One of the justified criticisms of the use of systems analysis data in education is the difficulty of analyzing and evaluating process. In a support paper prepared for the President's Commission on Instructional Technology, Speagle (1970) explained the difficulties that exist in transfering the cost-benefit techniques of business and defense to education. He also reviewed specific pioneering cost-benefit studies, particularly those aimed at evaluating new instructional media. His overall conclusion is that meaningful cost-benefit analysis in the most important areas of education is not feasible until a scientific base on educational processes has been established.

Predictive Costs

Building upon the Michigan State and General Learning Corporation Studies, Chappell (1970) designed a predictive unit cost model that can be used in instructional development planning after behavorial objectives have initially been stated and a slide or audio tape-film mode has been selected. Validation studies of his model indicate that all relevant costs incurred from objective selection until validated self instructional modules are ready for use by learners can be predicted within plus or minus 15% of cost analysis results. Cost analysis data which were determined at the end of surveyed developmental projects included costs for faculty and

related personnel, carrel equipment, software production and duplication, consultants, facilities modification, validation, and revision.

The model is designed for biological and physical science areas within higher education and generalization to other areas of curriculum development will require model revision. The procedures employed in developing the model are discussed and provide valuable guidelines for cost model builders. Chappell does not consider replacement costs, depreciation, inheritance, or annual and lifetime operation costs.

As stated earlier, a computer-based cost-estimating model for use in predicting investment and annual operating costs as well as total costs of instructional development projects is being developed by the Rand Corporation (Petruschell & Carpenter, 1972). Such a model will assist in financial planning and control but it will still require the user to supply cost estimating relationships and unit cost predictions based on available relevant data.

Neither the Chappell nor the Rand model is designed to supply both predicted costs and predicted effectiveness of an instructional alternative. They are, however, giant steps toward that goal.

Comprehensive Approaches

A university management information system that collects, stores, and distributes needed information simplifies the task of systems analysis. One of the more promising management information systems for higher education is one developed by the Systems Research Group of the University of Toronto. The Comprehensive Analytical Methods for Planning University Systems (CAMPUS) simulation system is designed to help college and university decision makers gain the maximum educational advantage from the resources which are put at their disposal (Systems Research Group, 1970).

The CAMPUS system is designed for simulating the allocation of monetary and physical resources but does not yet emphasize identification and measurement of educational outputs or effectiveness. The system makes use of data already existing in some form on most university campuses. By making use of such information as faculty teaching loads, classroom space, tuition and student credit hours produced, this system does provide unit cost information and other comparative measures of efficiency but it does not provide means of examining effectiveness of cost effectiveness. As of January 1970, the system was being used by a number of North American education institutions and implementation efforts were beginning in more than 20 universities and community colleges (Judy, 1970). Additional review of this system is included in the following section. If these applications continue to concentrate on fiscal and physical facilities information and do not include information on instructional effectiveness, it will be possible to analyze institutional efficiency but a comprehensive systems analysis will not be possible.

The National Center for Higher Education Management Systems (NCHEMS) at the Western Interstate Commission for Higher Education (WICHE) in Boulder, Colorado, has designed a management information system that aids decision

makers in looking at both the efficiency and effectiveness of higher education. In addition to their cost and resource allocation interests, an inventory of higher education outcomes is being developed which will contribute to the development of a cost effectiveness management information system (Lawrency, Weathersby & Patterson, Eds., 1970). WICHE was originally established to help colleges and universities in 13 western states improve their educational programs and management systems. The national center (NCHEMS) is developing management tools and procedures that can be used by higher education institutions in all of the United States rather than just the western states.

The focus of the first phase of the output inventory project is to collect data and measures related to students at times of entrance and exit from institutions and to add measures of long-term benefits, later contributions, and other characteristics as they evolve. The inventory is categorized as follows:

I. Instructional Outcomes
   A. Cognitive attributes of students
   B. Affective attributes of students
   C. Tangible attributes of students

II. Instructional Environment Variables
   A. Academic environment attributes
   B. Social environment attributes

III. Research Outcomes

IV. Public Service Outcomes (Huff, 1971 b, p. 15-33).

The rationale for the total system is well stated by Huff. "To examine the costs of educational programs with little or no evidence available related to the outputs of those programs offers relatively little advantage to educational decision makers (Huff, 1971 a, p. 2)." Not only do they propose a system which will measure the influence of an institution on educational outputs and then assign dollar costs to those outputs, they also are developing common data codes and conversion programs which will allow information exchange and comparison between institutions (Lawrence, 1969). It must be emphasized that these two comprehensive systems (CAMPUS and NCHEMS) are designed to provide data for higher education administrators. Neither is currently being used by teacher educators. Both models are discussed in detail in the following section.

SUMMARY

A review of the literature relevant to systems analysis shows no lack of theoretical models. Review of promising applications of systems analysis techniques and models reveals many examples of applications of various components. Large comprehensive management information systems are in various stages of development and will provide needed information for higher level decision makers.

Management information systems are generally not being designed to provide information suitable for use in making instructional design and

development decisions for teacher educators. With a comprehensive system, it is not usually feasible to collect cost and effectiveness data at any level below the course level. Supplementary cost and effectiveness analysis procedures need to be developed so as to provide descriptive, predictive, and comparative data appropriate for course, unit, and module level instructional design and resource allocation decisions. Better procedures need to be devised for relating costs, effectiveness, and feasibility considerations for both ongoing and projected instructional alternatives.

This review section has attempted to pull together several separate disciplines. Principles of economics, operations research techniques, and the practices of instructional development have all been considered and an attempt has been made to create a multi-disciplinary approach to decision making for both pre- and in-service teacher education. Grave injustices have been done to each of the so-called disciplines, but if teacher education is to survive, not to mention improve, new approaches to educational management and decision making must be attempted. A concerted joint effort will need to be made by skilled individuals in many fields to help us adapt to the rapidly changing social, cultural, economic, and educational needs of the 1970's and 80's.

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Appendix D

Cost-Effectiveness Analysis Alternatives for Open Learning Programs

by

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November 1974

COST-EFFECTIVENESS ANALYSIS ALTERNATIVES FOR OPEN LEARNING PROGRAMS

Philip Doughty

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November 1, 1974

ABSTRACT: Cost-Effectiveness Analysis Alternatives for Open Learning Programs

by

Philip Doughty

Planners of cost-effectiveness studies within UMA-SUN are faced with several options, according to the author. One option is the selection of variables which are likely to impact on quality and effectiveness. Indicators of quality may be identified from several viewpoints: from that of the psychologist, content specialist, producer/director, instructional developer/evaluator, or student. The author concludes that design, development, production, and operation (delivery) costs for UMA-SUN are influenced by such variables as: length and quality of video production; amount and difficulty of required readings; number and types of assessment procedures; and, amount of student contact with learning centers.

A second option facing the planner of cost-effectiveness studies is where to invest limited resources for such studies. The author suggests four areas as prerequisites for cost-effectiveness analysis: (1) proper analysis of costs for development and operation (delivery); (2) assessment of needs; (3) specification of objectives; and, (4) design of assessment procedures.

A third option is whether or not to examine the cost-effectiveness of extant instructional resources, for the purpose of acquisition decisions. The author offers the caveat that low-cost acquired courses may result in high-cost operations (delivery) of those courses. Long-range implications of course acquisition could be a focus for cost-effectiveness studies.

A fourth option for those who plan cost-effectiveness studies is the extent to which clientele of open learning programs create benefits or costs for other programs. Cost-effectiveness studies could concentrate on benefits derived for existing (conventional) programs, the social benefit derived for a community or state, or the benefit which an individual derives from alternatives among several

programs. Again, the author offers the caveat that the immediate goal for an innovative, technology-based program that requires support from conventional institutions would be: (a) to serve learners not currently being served by conventional institutions, and to document who those learners are and the benefits that they derive from the program; and, (b) to demonstrate benefits accruing to existing programs which outweigh the costs.

The final section of the paper raises questions pertinent to cost-effectiveness analysis for UMA-SUN.

Intended Primary Audience:	State University of Nebraska (S-U-N) Staff Members
Potential Secondary Use:	S-U-N reports to NIE and U-M-A
Content-Context Descriptors:	Cost Analysis Cost-Effectiveness Analysis Open-Learning Programs Quality/Value/Benefits
Reader Prerequisites:	Interest in allocating resources for the purpose of instructional program planning, production, and operation. Prior reading of "The Economics of an Open Learning System" by Richard Attiyeh, (S-U-N report, May, 1974) would be helpful but not essential. This report does not purport to duplicate nor compete with that position statement but does ask questions related to it.
Writer Comment:	Ideas, notions and recommendations expressed herein do not necessarily reflect S-U-N input and most likely suffer from a lack thereof. The intent of this brief paper is to provoke in-house discussion, debate, and perhaps consternation. If it stimulates none of those then most likely this all has been a misuse of the writer's and reader's time.

Overview

The paper is organized around three general and hopefully relevant topic areas. The first relates to several indicators of quality instructional programs that impact on various dollar costs. The second concerns a possible political and financial problem for many open learning programs. The third section contains the beginning of a set of cost-effectiveness analysis questions focusing on open learning systems. They are intended to serve as catalysts for the generation of more and better analysis and evaluation questions.

Indicators of Quality: Impact on Costs

If cost analysts were to identify and ask four different groups of professionals to recommend areas where extra S-U-N resources should be allocated in order to influence the quality of a course, the following lists might evolve: (Assume for the moment that such mutually exclusive subsets of professionals exist.)

1. Psychologists/Educational Psychologists: Emphasize long term retention, individual diagnosis and prescription, transfer of skills and knowledge, generalizability, and other similar higher-order intellectual skills.
2. Content Specialists: Insist upon accuracy, realism, proper sequencing, scholarly emphasis, and content stability.
3. Producers/Directors: Utilize quality writers, actors and narrators, well designed sets, realistic sound, appropriate color, and creative editing.
4. Instructional Developers/Evaluators: Generate or select a script (written materials) that will motivate; provide the learner with knowledge of intended goals and related assessment criteria; systematically design or format courses that

include appropriate sequencing of concepts with provisions for review and feedback.

The learner incidentally may reject all this and simply request a program (course) that provides pure enjoyment, comic relief, or escape from reality.

Resource Allocation for Evaluation

No existing "computerized multi-variate cost-effectiveness analysis" program will array a set of options like these and generate a mix that will optimally pair inputs with outcomes. S-U-N planners and evaluators must instead make selections on the basis of needs assessment data, available personnel and facilities, and a past history of design, development, production, and operation variables. Such data, particularly dollar costs for development and operation, are not often analyzed properly or even collected thereby denying planners the data needed for making valid cost predictions.

The other side of the predictive cost-effectiveness analysis issue also merits brief discussion. Predicting outcomes of even well defined instructional strategies is a task reserved for a resident Picasso. On the other hand, rigid prespecification of learner outcomes and standards regardless of cost is best reserved for trainers of parachute packers. There are several areas within this purview where S-U-N evaluation staff might be well advised to allocate time and resources.

Given current S-U-N programs and personnel, it is important for evaluation team members to consider the many alternatives open to them. Long range vs. short range, description vs. comparison, cognitive learner outcomes vs.

societal benefits, and dollar costs for tuition vs. total opportunity costs are all examples of potentially useful evaluation studies. Just where and when to invest valuable evaluation staff time is perhaps one of the most difficult resource allocation problems.

Perceived Value of Courses

Another subset of the larger quality question is particularly interesting. That subset includes the rationale potential learners use to judge the value of a course. To analyze this question, economists might argue for a global (absolute) approach i.e., "Given an infinite variety of ways to spend my time and money, should I invest in that course?" Many educators on the other hand might recommend a more restricted (comparative) view: i.e., "Given the range of educational options open to me, which course or program or university should I embrace." The outcomes of a value analysis from either perspective could possibly help S-U-N planners select, design and "market" courses.

For example, a potential learner's perceived value or utility of a course may be influenced by a number of variables that impact on dollar costs. The length and quality of video productions, amount and difficulty of required readings, amount of writing, number and type of assessments, and amount of required contact with regional learning centers will likely influence initial and subsequent enrollments. They will without a doubt influence design, development, production and operation costs.

At this time, we can only speculate on whether the learner's value criteria are absolute (too much or too little), comparative (competing courses and programs), or a bewildering combination of standards, needs and expectations. Systematic speculation may be better than counting on

serendipity but neither can compete with well organized data - - particularly when that data relates directly to high priority questions.

From a cost-effectiveness analysis perspective, attention paid to needs assessment, objective specification, assessment procedure design, and comprehensive validation are essential. Needless to say they are also relatively costly and laborious activities. Without these, validation and evaluation of course components, courses, and programs are impossible. Without these, defenses for quality programs, comparisons of alternatives, and cost-effectiveness analyses cannot be conducted. Conversely, it makes little economic sense to invest time and dollars in "validating" an expensive video component of a course if the intent is to revise that component when it doesn't produce. It does, however, make good sense to test that component to identify weaknesses which can be remedied via adjunctive materials providing review, feedback, remediation, and practice exercises. Of course these materials boost the amount of recurring and variable (with enrollment) operation costs of a course but it is unrealistic to expect even a thrice revised video package to carry the total instructional load for most courses.

Adaption-Adoption-Collaboration

Planners for open learning educational alternatives like S-U-N and U-M-A should continue to make every effort to identify and analyze both the costs and potential benefits of using already existing facilities and programs. The temptation to incorporate or collaborate is great since initial investment and/or phase-in costs are often relatively low. At second glance, however, these low cost windfalls can lead to high cost repetitive maintenance, replacement, and other operation expenses over time. This does not necessarily

suggest that building collaborative networks with existing production agencies or delivery systems is unwise. It only presents the case for thorough examination of long range implications of such liaisons.

It makes little sense economically to procure existing programs and then proceed to spend considerable monies revising the video components. This is particularly true if time and the number of courses ready for use are both scarce. Assuming that the programs meet some predetermined content and production quality criteria, cursory analysis would suggest that considerably less time and dollars could be spent revising assessment procedures, course guides, and vital adjunctive instructional materials. This obviously requires considerable compromise by content specialists, producers, directors, et.al., but in the end the outcomes may be nearly the same. This is an alternative that could merit a dash of empirically based analysis.

Potential Problems

One potential political and financial roadblock lies directly ahead for open-learning type programs. Assuming that new programs will require external dollars to offset initial startup costs, the problem then focuses on the financial relationships between open learning systems and extant conventional post-secondary institutions. Those courses or course sequences that offer potentially significant economies of scale for open-learning/high technology programs are oftentimes the same courses that provide considerable income for conventional departments and colleges (i.e.: basic english, foundations of psychology, introduction to American History, political science, biology, etc.).

A Dean supporting liaisons with non traditional educational programs may

very well be cutting the financial heart and recruiting foundation out of a department or school at a time when students are becoming increasingly scarce. If commensurate benefits are not identified, a lack of support or outright opposition will be forthcoming. This has implications for many cost related issues: broad base funding support at state and national levels, acceptability of transfer credit, accreditation, and content specialist/academic department support.

If open-learning systems do in fact cater only to learners not currently being served by conventional institutions or if they serve as a recruiting vehicle for conventional programs, then this potential for competition and conflict ceases to be an issue and instead becomes a basis for considerable academic and political support. This somewhat negates defensable open learning program verbage about generating worthwhile alternatives and autonomy but political and financial realities may force planners to temper those notions for the immediate future.

The immediate goal for innovative, technology-based programs that require support from conventional institutions then may not be to advocate and promote efficiency or productivity since those notions may very well fall upon threatened ears. The challenge could be to design, produce, and promote efficient and effective programs for potential learners not currently being served.

Questions With Cost Implications

The following cost-effectiveness analysis oriented questions may be worthy topics for S-U-N planning and evaluation staff considerations:

1. What should be the basis for tuition in non-credit, non-degree oriented courses? Perhaps: a) hours of broadcast time, b) objectives accomplished, c) course credit equivalents, or d) course enrollment?
2. What might be the impact of an intensive cost-shifting policy, i.e., requiring learners to pay for goods and services normally provided by conventional programs? This may help cut direct program costs but may negatively influence enrollment or learner affect.
3. What is an optimal range of time and dollars expended for course planning compared to development or production? Which of those functions impact most on total dollar costs for course implementation and operation? What is a realistic cost range for evaluation and/or cost-effectiveness analysis studies?
4. How long must comparative studies on retention, application, etc. be continued before the data will help to substantiate or refute arguments for high cost programs? Can high quality programs be defended using only short duration assessment data?
5. Will high quality programs aimed at creating positive affect influence re-enrollment rates in non-credit courses? In credit courses? In degree or credentialling programs?

6. What will be the impact of different types of courses on the operation costs of learning service centers?
7. How do you justify maintaining a relatively high cost television production facility if high-quality course productions become unfeasible or unfundable? What kinds of resources are required to adapt existing programs for open-learning environments?
8. Can cost-per-thruput (cost per student credit hour) measures be used to make valid comparisons between unlike instructional programs? Between relatively similar programs? Are there alternatives to the use of such measures?

Comment

As governing systems like U-M-A grow stronger, subsidiaries like S-U-N will be required to give up some autonomy in exchange for increased access to learners and programs. Theoretically this will lead to the economies of scale required to justify considerable expenditures for design and development of quality programs. Without the economies offered by consortia or networks, it will be difficult if not impossible for S-U-N to compete financially and politically with actual or theoretical alternatives that emphasize lower cost technologies and adaptations of existing programs.